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Aims and Scope

Indian Journal of Mechanical and Thermal Engineering is a peer-reviewed journal for the presentation of original contributions and the exchange of knowledge and experience on the sciences of heat transfer and thermodynamics, and contribute to the literature of engineering sciences on the national and international areas but also help the development of mechanical engineering. engineers and academicians from disciplines of power plant engineering, energy engineering, building services engineering, HVAC engineering, solar engineering, Wind engineering, Nano engineering, surface engineering, thin film technologies, and computer aided engineering will be expected to benefit from this journal's conclusions.

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Contents

Adoption and evaluation of engine driven groundnut stripping machine for small holder

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ABSTRACT

Groundnut stripping is necessary process subsequent harvesting because of pods are attached to most of low acreage groundnut growers. Manually groundnut pod stripping is time consuming and drudgery on farmers. The aim of this study was adoption, evaluation and fabrication easily affordable groundnut stripping machine. The machine operated by diesel engine capacity of 3.75 KW motor. The performance evaluation of machine was conducted on two-moisture content groundnut vine and three engine operating speed with three replication. Maximum threshing or stripping capacity of machine recorded as 501 kg per hour. The maximum and minimum stripping efficiencies of 98.2% to 94.7% produced by wet groundnut vine (60% moisture content) or stripping immediately after harvest with drum speed of 400 rpm and dry (17.5% moisture content) stripping with 600 rpm operating speed respectively. Both Moisture content of ground vine and operating speed had significant effect on stripping rate and percentage of unstripped pod. Maximum stripping rate (SR) and percentage unstripped pod (PUSP) of a machine was recorded by dry stripping with drum speed of 600 and 400 rpm respectively. While minimum SR and PUSP recorded at wet groundnut vine stripping with drum speed of 200 and 600 rpm correspondingly. Generally, it can be conclude that drying before stripping resulted in best output (total stripped pod) with (400-rpm) beater speed when compared with threshing immediate at harvest. More over drying after harvest with drum speed (SIII) stripping produce the highest stripping rate though it resulted in high pod scattering, percentage of unstripped pod and chaff and impurity. In terms of Economic benefits machine 15.67 times over manual or hand pulled with the same operation (stripping per 3 mans per day). Therefore, further promoting and expanding the machine can reduces work drudgery and time consuming of groundnut pod by hand pulling under smallholder's future.

Keywords: Stripper, groundnut, stripping rate, stripping efficiency, economic feasibility

Introduction

Groundnut stripping is necessary processes subsequent to harvesting because of pods are attached to groundnut vines or stem. Local farmers are encountered several difficulties in stripping as it required relatively high expenditure of human energy. Stripping has previously been accomplished either by hammering the pods on the ground to separate pods from it vine or stem. These methods results in serious bruising of human fingers. The most common practice for stripping in irrigated area is to strip within 1 or 2 days after harvesting Ghatge et al, 2014 [4].

Threshing operations also varies both within and among the developing countries. It varies from the age-old procedure of using sticks and racks to the modern power threshers. The smallholder and

marginal farmers do manual threshing using sticks and rakes. Variations also exist in stripping pods of the plant. After harvest for example, bunch type plants are stacked in heaps with the pod-end exposed. After the crop has remained in this state for a week or so the pegs become brittle and the pods are plucked from the plants with labor. This operation is comparatively difficult as the attachment of peg to pod is stronger, but drying the plants for a few days facilitates this operation Nautiyal, 2002 [6].

According to Nautiyal, (2002) [6] stripping done by picking pod by pod with an average capacity of 25 kg of pod per person-day. Physical appearance of groundnut from this area is generally good i.e. less pods with vine attached and less impurities. For rain fed area, most of groundnut plants are dried in the fields for 4 to 5 days before stripping by pulling a handful of pods from plants.

Ghatge et al, 2014 [4] reported that for poor groundnut quality in term of physical appearance hand or manual stripping could reach up to 62 kg of pod per person-day)

Sometimes the stripping of the pods is also performed simultaneously with harvesting when the cropped area is small and laborers are available. In this case, the pods are dried immediately after stripping. The usual practice is to separate pods by beating the pod-end of the plants against a rough stone or a thick iron rod.

Though ground nut production is high, problem of the threshing or stripping have not yet get solution at all areas due to unavailability of modern technology in developing countries like Ethiopia. Unlike others, our farmers not aware of the groundnut threshing technology existence in the world or in home land. Hence, farmers' uses hand stripping by groups of family (Dabo), which is time taking activity and laborious. Therefore, the aim of this study was adopting engine driven groundnut stripper machine at farmer's level to reduce groundnut post-harvest loss.

Materials and Methods

Description of study area

The experiment was conducted on farmer's field at Jalele kebele of Bable woreda, Eastern Hararge Zone of Oromia Regional State during harvesting time of ground nut (November 2016). Babble is situated at 090 14 ″05 ′25 090 –″ 15′north latitude and 420 17 ′20 ′28 420 - ″28 ′east longitude at an altitude of 1670 m a.s.l. It is located at 587 km from Addis Ababa, and 31 km from Harar town. Major crops grown in the study area was sorghum, maize, chat and fruit and vegetable under irrigation. Commonly grown cash crops, in the vicinity of the site, under rain-fed at main season was ground nut and chat

Description of the machine components

The main components of the machine consists of frame, engine seat, stripping blade, feeding table shafts, bearing and pulley, The frame was made from rectangular pipe size 40 mm × 30 mm with stand height of 1200 mm. Engine seat was manufactured from square pipes of 20 mm × 20 mm. It designed to

hold engine with better balance and stability during operation.

Power transmission unit: The pulley, shaft and A-type Vbelt connection used for power transmission. Shaft having 30 mm diameter was selected in order to transmit required power to different. The experiment was conducted by one cylinder KAMA engine, air cooling, and diesel fuel. The engine output power of 3.75 kW at full injection operate speed was 1500 - 1800 rpm

Stripping unit: This is a unit, which actually strips out the pods from the groundnut.

Table 1: General description of engine driven groundnut stripper

Description	Dimension
Dimensions (l x w x h) (mm)	1300 x 600x 1200
Cylinder concave (upper and lower cover) diameter x length (mm)	170 x 1100
Beater size diameter (mm)	300
Power source (HP)	3.75 KW diesel engine
No. of person required for operation	3 per feed (Used during operation)
Power transmission unit	
Shaft diameter (mm)	30
Diameter of driven pulley (mm)	460
Diameter of driver pulley (mm)	140
V-belt	84 -A-type
Bearings (Pair) P 205 internal Diam. 30 mm	P 205 internal Diam. 30 mm

Design preparation and prototype production

The detail drawing was prepared before starting manufacturing prototype of a machine. After complete set of drawing and necessary materials were procured, manufacturing of the prototype of stripper was made. Accordingly, the machine covers were prepared from sheet metal of a thickness 1.5 mm on bending and rolling machine. Then Beater was made from flat iron of 4 mm thickness arranged in circular pattern at an angle of 150 degree on flat circular plate at both side and directly hinged on shaft.

Frame was made from angle iron and rectangular pipe, which was used for complete support of assembled part of the machine.

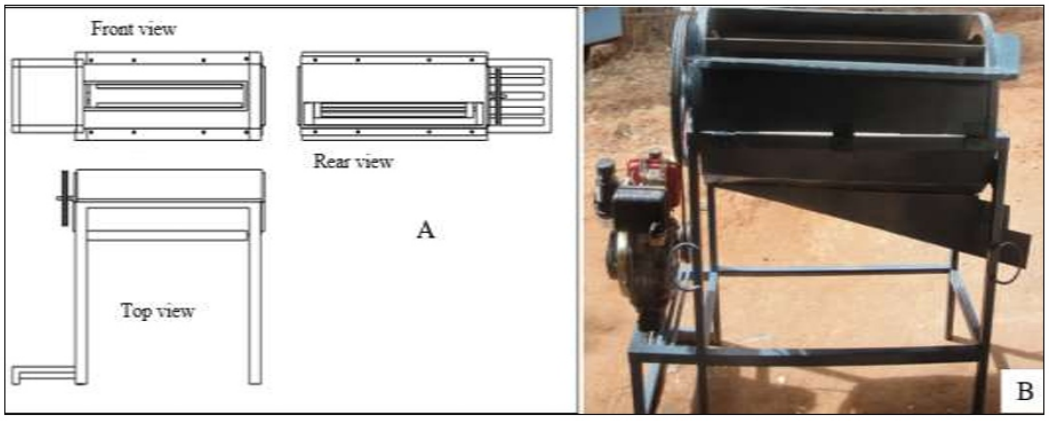

Fig 1: A) Machine drawing and (B) is Prototype of developed groundnut stripper machine

Performance evaluation of the adopted groundnut stripper

After manufacturing was machine performance, evaluated on the following parameters:

Stripping rate (SR): It was the quantity of the groundnut pods detached from the vein in unit time. It is calculated as according to Ghatge et al, 2014 [4]

$$SR = \frac{WP}{TS} \quad (1)$$

Where

SR - stripping rate (kg hr-1), WP - weight of stripped pod (kg) and TS - stripping time (hr)

Percentage of unstripped pods: The quantity of the groundnut pods not detached from the vein in unit time and expressed as:

$$PUSP = \frac{WUSP}{TWP} x100 \quad (2)$$

Where

PUSP - Percentage of unstripped pods, WUSP - weight of unstripped pods (kg) and TWP - total weight of pods (kg)

Stripping efficiency (SE): SE (%) was calculated according to Afify et al., (2007) [1] following FAO 1994 outline equation

$$SE = \frac{WSP - LOSS}{TWP} X100 \quad (3)$$

Where: SE - stripping efficiency (%), WSP - weight of stripped pod (kg) and TWS - total weight of pod (kg)

Experimental procedure

The performance test of the machine was conducted with three levels of drum speed (200 rpm, 400 rpm and 600rmp) and two levels of moisture content (immediately after harvest at average moisture level as 60% in mass bases and drying for 5 days after harvest with normal sun shine moisture level as 17.5%). a total of 6 experiments with three replications were conducted in order to determine the range of drum speed and moisture content that gives the best performance of the machine. Moisture measurement was done by weighing wet sample at harvest and dry sample following procedures outlined by FAO, 1994 on weight base by taking leave and branch stem of groundnut. Moisture content was determined using oven dry at 105 0C for 24 hour.

Table 2: Combination of experimental treatments

Treatment	Combinations	
T_1	D x S_{II}	(Dry with speed of 200 rpm)
T_2	D x S_I	(Dry with speed of 400 rpm)
T_3	D x S_{III}	(Dry with speed of 600 rpm)
T_4	W x S_I	(Wet with speed of 200 rpm)
T_5	W x S_{II}	(Wet with speed of 400 rpm)
T_6	W x S_{III}	(Wet with speed of 600 rpm)

Performance evaluation made following FAO (1994) procedure and criteria for evaluation of threshing machine parameters, which includes stripping efficiency (SE), stripping rate (SR), stripping time (ST), and percentage of unstripped pods (PUSP).

Data analysis

All data were subjected to analysis of variance appropriate for factorial randomized complete block design (RCBD). The data were analyzed using statistix-8 software. The mean separation was made using fisher protected list significant difference (LSD) method.

Result and Discussion

The test was conducted with three persons at a time feeding for groundnut pod stripping machine operation. The constructed groundnut stripper was used to carry out the performance evaluation. The results of the mean performance parameter for the groundnut stripper at two moisture contents for different engine speeds are presented as follow;

Stripping rate

ANOVA result indicated that stripping rate (SRrate) of machine was highly significantly ($p<0.01$) affected by both working speed and moisture levels (stripping immediately at harvest moisture level and drying time for 5 day after harvest with normal sunshine). The highest and lowest mean stripping rate of a machine obtained as 501 and 273 kg hr-1) by treatment D x SIII and W x SI respectively (Table 3). The result revealed that average stripping rate of the machine, at immediately after harvested moisture level stripping with drum speed of 200 rpm had 45.5% lower than drying with drum speed of SIII (600 rpm) with same average feeding rate of 345 kg hr-1 Table 3. This showed that treatment dried for a 5 days stripped with drum speed of 200, 400 and 600 rpm found as 25.54%, 33% and 21.77% higher than moist treatment (stripped immediate after harvest) with the same operating speed respectively. This is resulted from fresh stripping take more time than dry stripping.

In contrast dry stripping resulted in, more impurity, higher pod scattering/loss, and increase percentage of unstripped pod. On the other hand, from the result, SR rate more affected by moisture than operating speed. This find agrees with Gol and Nada (1991) [5] report; Percentage of stripping pods increased by increasing of peripheral drum speed which ranged from 473-675 rpm. The concluded as significant

factors affecting the efficiency of mechanical pod stripping elements are operating speed and crop conditions. Similarly, Ajayi (1991) [2] discussed as, moisture content of the crop influences the capacity of a locust bean thresher. Threshing effectiveness found as affected by the cylinder speed. Ghatge, et al. (2014) [4] explained that, most of groundnut plants are dried in the fields for 4 to 5 days before stripping or pulling a handful of pods from plants, this method of stripping results in a relatively high capacity (62 kg of pod man-1 day-1). From this result deduced value of stripping rate per person per hour for 8 hour working time 62 kg and for one hour is 7.75 kg hr-1. Therefore average stripping rate per hour of dried groundnut pod stripped by machine was 10.74 times or 90.69% higher than when stripped by person or traditional hand stripping method.

Stripping efficiency

The stripping efficiency of a machine was affected by different operating parameters such as moisture content and stripping drum speed. ANOVA result shows that machine stripping efficiency was significantly ($p<0.05$) affected by drum speed, but moisture level had not significant ($p<0.05$) effect on machine stripping efficiency (Table 3). The highest mean stripping efficiency was found as 98.2% by wet stripping with SII (400 rpm) drum operating speed and the lowest 94.7% was recorded by dry stripping with 600rpm drum speed (Table 3). The result showed that increasing operating speed reduces stripping efficiency and increase pod loss. On the other hand dry threshing increases the excessive plants leaves or chaff drop, but stripping immediately at harvest or 60% Moisture content shows good stripped pod quality but slightly reduce output or stripping rate of machine.

The result confirmed with, Afify et al. 2007 [1] reported, they explained that increasing feed rate from 600 to 900 kg hr-1 at constant drum speed of 6.28 m s-1 and seed moisture content of 13.63%, decreased the stripping efficiency by 0.97%. According to Simonyan and Oni (2001) [8], there is an increase trend in threshing efficiency and extractor efficiency with decrease in moisture content. Threshing effectiveness affected by the cylinder speed.

Table 3: Interaction effect of moisture level and operating speed on groundnut stripping machine

Treatment	WSP (kg)	WUSP (kg)	SR $_{rate}$ (kg hr^{-1})	PUSP (%)	Loss (kg)	SE (%)
D x S_{II}	5.89^{a}	0.110^{a}	413^{b}	1.82^{a}	NA	97.3^{a}
D x S_{I}	5.74^{a}	0.095^{ab}	349^{bc}	1.61^{ab}	0.03^{b}	97.5^{a}
D x S_{III}	5.13^{b}	0.084^{b}	501^{a}	1.56^{ab}	0.10^{a}	94.7^{b}
W x S_{I}	5.46^{ab}	0.085^{b}	273^{c}	1.53^{ab}	NA	98.1^{a}
W x S_{II}	5.39^{ab}	0.074^{b}	276^{c}	1.35^{b}	0.02^{b}	98.2^{a}
W x S_{III}	5.50^{ab}	0.048^{c}	373^{b}	0.84^{c}	0.10^{a}	95.6^{b}
CV	4.9	14.8	12.7	15.2	54.3	0.9

Note D: Drying for 5 day before stripping, W: Wet (stripping immediately at harvest), SI. SII, SIII is operating speed at 200, 400 and 600 rpm operating speed

Percentage of unstripped pod (PUSP) and pod loss Threshing capacity of a machine may affected by different physical characteristics of crop. ANOVA result indicated that percentage of unstripped pods (PUSP) pod loss were highly significantly ($p<0.01$) affected by moisture level and drum speed (Table 3). The highest mean PUSP of 1.82%, was recorded by 5 days drying after harvest (17.5% moisture level) stripping with 400 rpm drum speed and, the lowest PUSP 0.84% was found by wet stripping with 600 rpm (SIII) drum operating speed.

Similarly the highest pod loss was observed as 0.1% and the lowest 0% or no loss was observed in both treatment moisture level (wet and dry) stripping with 600 rpm and 200 rpm respectively. More over statistical output showed pod loss was not affected by moisture content of ground nut vine, whereas operated speed had significant effect on pod loss i.e. as beater speed increase pod scattered out increases. Moreover, the effect of beater/drum speed versus pods loss plotted indicated as; initial machine operating speed (200 rpm) there is no pod loss or negligible, whereas at second drum speed (400 rpm) pod scattering was slightly observed as shown in Table 3 and figure 1. While at 600 rpm and above drum speed stripped pod loss increase considerable.

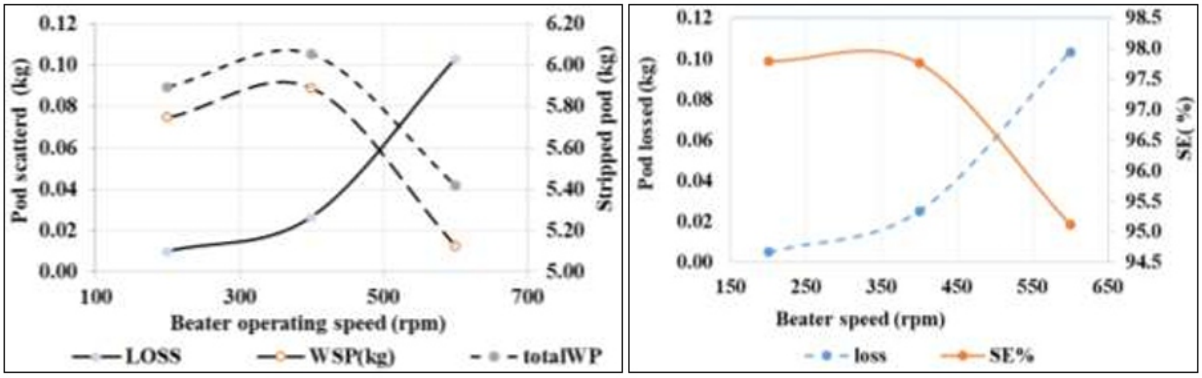

Fig 2: Effect of drum speed on pod scattering loss and SE (%)

Figure 3 indicates as drum speed increases pod loss or pod scattering increasing, which means, explicitly SE was also influenced by those operation. The SE initially low at 200 rpm and increasing gradually; reached at maximum at 400 rpm then decreasing gradually figure 3.

The result obtained by Afify et al. (2007) [1] confirmed with this study. The result showed that decrease in the percentage of stripping efficiency by increasing feed rate attributed to the excessive plants in the threshing chamber. Consequently, the seeds leave the device without complete stripping from the capsules. Additionally their finding reveals increasing drum speed from 4.19 to 7.32 m s-1 at constant feed rate of 600 kg hr-1 and seed moisture content of 13.63% increased the stripping efficiency by 1.31%.

Similarly, as drum speed, increases pod loss or pod scattering increasing, amount of pod stripped per

unit time decreases; which means, explicitly SE (%) was also influenced by those parameters. Thus, SE (%) initially low at 200 rpm and increasing gradually; reached at maximum at 400 rpm then decreasing gradually figure 3.

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Weight of stripped and unstripped pod weight ANOVA output show that weight stripped or threshed pod weight (WSP) of groundnut was statistical significantly ($p<0.05$) affected by interaction effect of moisture level and operating speed. The highest mean stripping weight was produced by D x SII as 5.89 kg and the lowest 5.13 kg by D x SIII (Table 3). This is due as beater speed increases pod scattering was increase. Similarly the unstripped pod weight of groundnut was highly significantly ($p<0.01$) influenced by both of moisture level and operating speed. The highest mean weight of unstripped pod recorded 0.11 kg and the lowest 0.048 kg by drying for 5 day after harvest stripping with 400 rpm operating speed and stripping immediately at harvesting at 600 rpm respectively Table 3. However, interaction result revealed that unstripped pod slightly increased on drying for 5 days by normal sun dried than fresh instantly stripped groundnut as shown in Table 3. This finding confirmed with Paulsen et al. (1980) [7] study, which pointed that the moisture content of grain is one of the major physical factors for the design and operation of the threshing machine that affect the mechanical damage to grains and threshing efficiency of machine.

Economic analysis of the machine

Handful pulling of pods from plants, stripping method results in a relatively 62 kg of pod/man-day this shows stripping rate per person per hour for one hour is 7.75 kg hrGhatge, et al (2014) [4]. Economic benefit of stripper machine estimated following.

Hence, economic analysis described as follow:

Total stripping per man per hour = 7.75 kg

Working hour = 8 hour per day

Total stripping per 3 mans per day = 3*7.75*8= 186 kg

Cost of laborer per day =100 ETB

Total Cost of manual piking per day = 300 ETB

Average machine stripping per hour = 364.2 kg

Total machine stripping kg per day = 364.2*8 = 2913.6 kg

Total cost = Labor cost + Fuel cost = (3*100) + 128 = 428 ETB day -1

Stripping cost per day = (Total machine stripping kg per day

÷ Total cost) = (2913.6 ÷ 428) = 6.81 ETB per day

Total stripping per 3 mans per day = 3*62= 186 kg (manual stripping)

From the calculation: manual stripping cost per 3 mans per day = 300 ETB to strip 186 kg and machine stripping cost per 3 mans per day = 428 ETB to strip 2913.6 kg

Conclusion and Recommendation

A groundnut-stripping machine was adopted and tested in mandate area of Babile district of East Hararge zone. This machine was tested under two factors namely, two moisture level (Immediate after harvest and stripping after drying for 5 days), and three machine operating speed, (200 rpm, 400 rpm and 600 rpm); from this experimental finding the following concluded and recommendation was drawn:

The highest mean interaction effect of stripping rate of a machine was 501 kg hr-1 5 day drying (17.5%) and drum speed of 600 rpm (D x SIII) treatment recorded 1). While minimum mean stripping rare (SR rate) of the machine found 273 kg hr-1 was obtained at immediate after harvest (60% ML) and drum speed of 200 rpm (W x SI) treatment with same average feeding rate of 345 kg hr-1. The highest and lowest mean stripping efficiency obtained as 98.2% and 94.7% by 400 and 600 rpm drum operating speed.

The highest mean machine stripping time was recorded by fresh harvested stripping with 200-rpm drum speed at immediate after harvest (60% ML) found 0.020 hr. While mean minimum stripping time was at drying for 5 day after harvested with drum, speed (D x SIII) was 0.0106 hr. Generally, it can be conclude that drying before stripping resulted in best output (total stripped pod) with (400-rpm) beater speed when compared with threshing immediate at harvest. More over drying after harvest with drum speed (SIII) stripping produce the highest stripping rate though it resulted in high pod scattering, percentage of unstripped pod, chaff and impurity.

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Analytical study of ventilation (Heat & mass transfer) effect in green house

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ABSTRACT

In comparison to all other agricultural industry sectors, the commercial greenhouse has the highest energy requirement. In this case, energy management is crucial from the standpoint of global sustainability. Under steady and unstable state conditions, it was examined how the temperature changed over time for different air change rates in the dry/wet soil, roof, side walls, internal air, and wetness of a greenhouse. The current research can predict the interior climate of the greenhouse for a given outside scenario and greenhouse material characteristics. The investigation of sensible features revealed a linear relationship between the temperature of different components and the roof transmissivity, soil reflectivity, and both.

Keywords: Analytical study, ventilation, green house

Introduction

Because of their inexpensive investment costs and potential to increase crop productivity by 10–20 times compared to outdoor agriculture; greenhouse shelters have been widely used for agricultural production [1]. In order to achieve the serialization and standardization of agricultural facilities, developed nations design suitable greenhouses in accordance with local environmental factors, agricultural resources, climate, and cultivation characteristics [2]. They also make full use of the standard solar global radiation facilities. The fundamental conceptual equations used to simulate the numerous processes in any thermal system, including the greenhouse, are mass and energy balance. Analysis of Indoor Temperature Distribution Crop output is significantly influenced by temperature in the environment. Plants' ability to absorb carbon and move electrons during photosynthesis are also influenced by temperature, but excessive heat can harm these organs [3-6]. Farmers are concerned about temperature since it is a key greenhouse environmental indicator. For temperature detection, almost all greenhouses are outfitted with liquid or electronic thermometers. The result of this experiment can be drawn by comparing the temperature data from the various types of greenhouses included in the experiment with those from each control group.

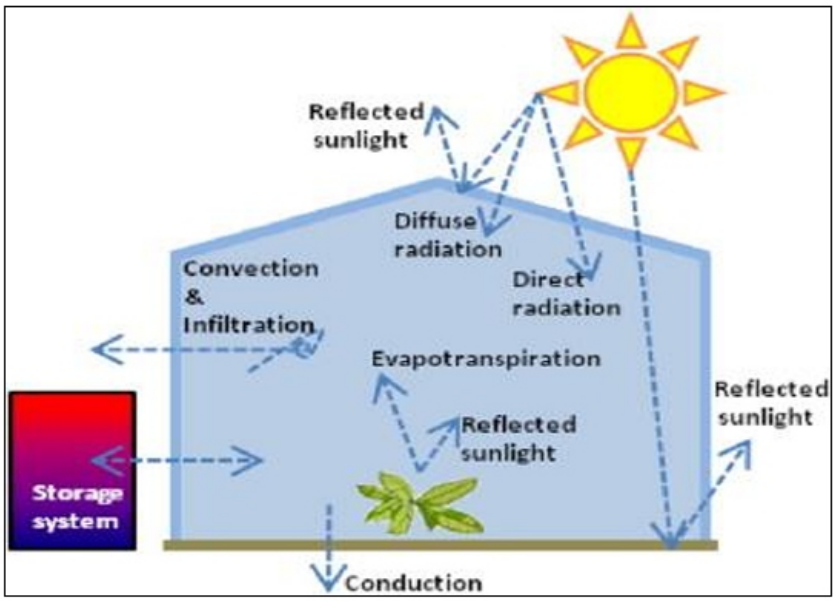

Fig 1: Green house model

The main goal of greenhouses is to produce agricultural goods outside of the growing season. 30% of the total operating expenditures in the greenhouse business are related to heating, which is accomplished using conventional fuel-burning equipment [7]. Although these studies have a lot of scientific study value, SSGs in Wei fang should not use them. There is a paucity of information regarding plant density and plant height in the greenhouses, two factors that should be taken into account while running the test. Additionally, regional climate characteristics differ from those of Wei fang. Second, the majority of research don't pay attention to the greenhouse's detailed operation and upkeep. A reasonable internal temperature and airflow are maintained by the ventilation system when the greenhouse system is in use. In most parts of China, greenhouse ventilation regulation is typically relied on staff experience and ignores objective test data. Therefore, when studying the greenhouse microclimate, it is important to take the presence of a ventilation system into account. However, the author of a study on the heat exchange of subterranean pipes in greenhouses [8] thought that the local greenhouse's ventilation was always closed in the winter. Researchers' assumptions about the operation scenario could differ from the real scenario. In addition, the solar heating and climate control system for greenhouses was studied [9]. The input factors used in the calculations are listed at the beginning of this paper. These variables include the environmental conditions, greenhouse size, greenhouse material properties, greenhouse component mass, view considerations, and air and water properties. These inputs are used to run the simulation. Simulation findings are produced for cases of both steady and erratic states in three different circumstances.

1. Empty greenhouse with dry soil
2. Empty greenhouse with wet soil

Greenhouse with plantation Innovative (selected surface) cover materials may improve summer growth conditions, minimize insect pressure, and save energy. Sonneveld et al. presented an innovative prototype greenhouse they had developed in 2010 that combined the generation of PV power with the reflection of near-infrared radiation. As a result of the study, the near-infrared greenhouse climate has improved. Bodalan Ciprian (2014) led a hypothetical investigation into heat transfer between nurseries and the environmental factors that affect them and came to the conclusion that the direction of intensity transfer in nurseries is variable, with heat accumulation during the daytime occasionally turning into a deficiency of intensity around dusk as well as the reverse. A nursery's total energy equilibrium, he continued, "clearly illustrates how radiation energy retained is utilised for happening, dissipation, reasonable intensity of the air, and soil warming." Every situation's temporal soil, inside air, roof, and sidewall fluctuation is charted and described [10]. Wet soil serves as a visual representation of the changing moisture content of greenhouse air over time. In this chapter, the findings from investigations on the effects of ventilation rate on soil, internal air, roof sidewalls, and plant temperatures are presented. Results on how plants' steady-state temperatures change over time are also given.

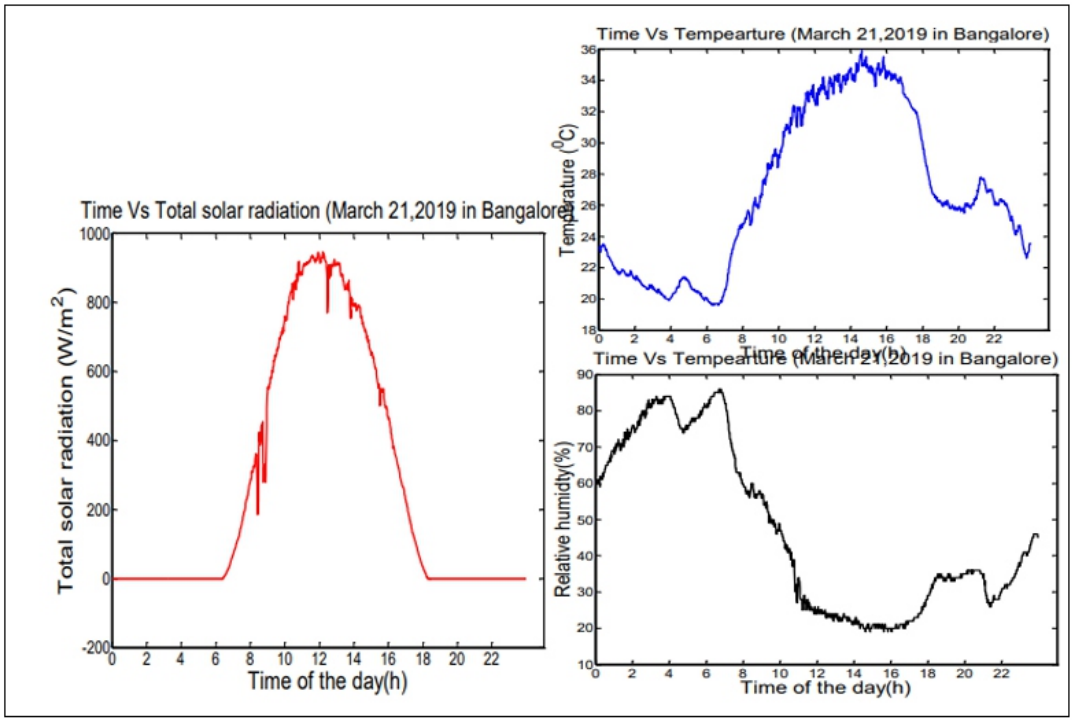

Fig 2: Depicts Bangalore's surrounding circumstances

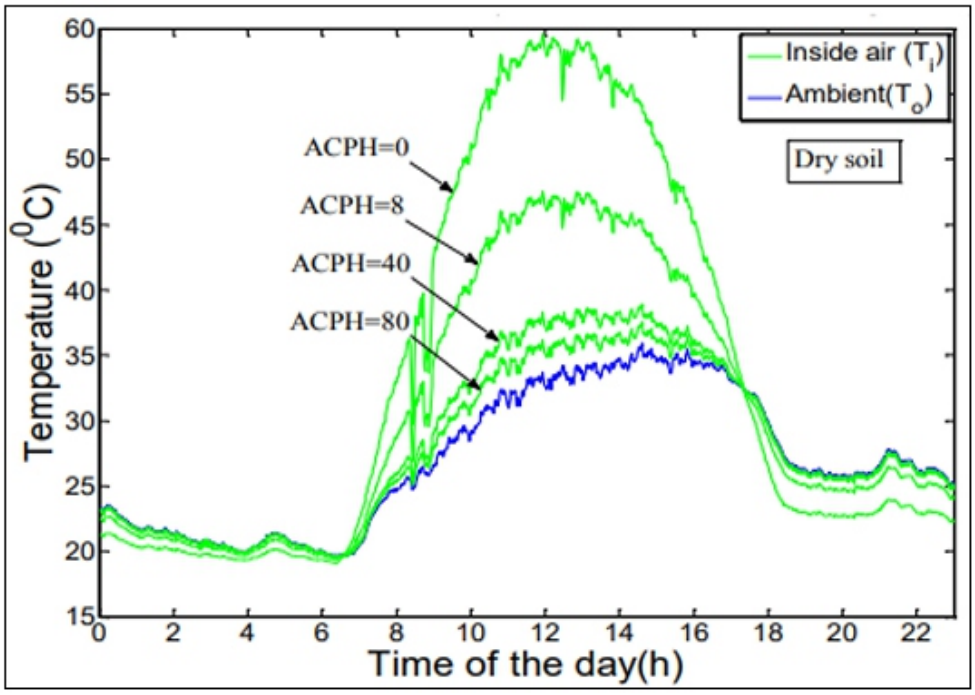

Fig 3: Variation of inside air temperature with time difference change

Conclusion and future investigation

We have shown that the surface energy balance of a greenhouse's numerous parts can be used to model the greenhouse, allowing for accurate predictions of the greenhouse's interior temperature over a wide variety of ventilation rates. We conducted a research and an analysis of unsteady states, compared the solutions, and demonstrated that unstable solutions resemble steady states. The time constant was discovered in steady state. The effects of different air changes in dry and wet soil conditions on the greenhouse surfaces' temperatures over time were investigated.

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Mechanical engineering's relevance in achieving long-term sustainability

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ABSTRACT

So far the development of the modern world has been dominated by science, engineering, and technology, and the role of an engineer is closely linked to the needs of society. But unfortunately, this modernization has given birth to many pressing challenges such as environmental pollution, depletion of resources, rapid population growth, and damaged ecosystem. Due to these drawbacks, our environment is looking for a shift in the route that modernization has taken. As the demand for this transition is growing, several scientific divisions are turning to their origin for a solution, which is mechanical engineering. Mechanical engineering, being one of the oldest scientific disciplines, is expected to produce some effective solutions for these difficulties. This article will explore the importance of mechanical engineering for this transition, and possible solutions with it.

Keywords: Engineers, mechanical, sustainable development, ecosystems, environmental pollution, society, economic resources, global challenges

Introduction

Since the second industrial revolution, the world has been teetering on the brink of a disaster, owing primarily to injudicious consumption of natural resources over a short period. Although the formation of fossil fuels took millions of years, we humans have nearly depleted them in just two centuries. This easily explains how these fuels have punctured the interminable equilibrium of our ecosystem.

According to a report published by the Potsdam Climate Institute, if carbon emissions are not reduced by half till 2030, our environment may descend into chaos. So being only nine years away from the deadline, it is quite lucid that raising concerns in the society and asking the public to reduce their dependence on dirty fuels in the absence of a viable alternative, would not get success in our bags. To be successful, we must look beyond the horizon and create something new.

Why action is needed from fields like mechanical engineering?

For the past 150 years, engineering practices have been based on a paradigm of controlling nature rather than cooperating with it. The majority of engineering achievements in the past did not consider the impacts of their creation on social, economic, and environmental systems, and an insufficient amount of attention was paid towards minimizing the risk and scale of unplanned perturbations in natural systems. Hence, in the control-of-nature paradigm, humans and the natural world have been divided, and humans have adopted an oppositional and manipulative stance toward nature.

As a result, the world is becoming more crowded every day, with more consumption and more pollution. To meet the increased demands for energy, food, land, water, transportation, materials, waste disposal, earthmoving, health care, environmental clean-up, and infrastructure, etc humans are extensively altering Earth's natural systems at all scales- from local to global- at unprecedented rates.
Hence after considering the negative impacts of these practices, it has become very important for technical fields, like mechanical engineering, to develop a solution and promote a holistic approach to these problems.

What is mechanical engineering and what is its significance?

Mechanical Engineering, also known as the mother of all the engineering branches, is the only engineering branch that combines the principles of physics and mathematics with material science, to design, analyze, manufacture, and maintain technical systems. It is one of the oldest and broadest branches of engineering.
Today many people believe that mechanical engineering is a dead field and is no longer productive. But they fail to realize that without mechanical engineering, our lives would've not been same as they are today. While we might not even realize it, every day we use something that is the product of this field. Due to so much involvement in our daily lives, mechanical engineering can help us to find the most suitable solution to the sprouting ecological problems. Mechanical Engineers have played and continue to play a key role in the future of sustainable development. Whether it is building new products or working on new technologies, they are instrumental in designing, contriving, and building the way products and services are delivered and consumed. They are the ones who carve the path to innovations and construct the base for solutions, which then are used by other branches to achieve them.

What is the relationship between our societal needs and Mechanical engineering?

Mechanical Engineers plan, design, and create the physical structure through which society lives works, and plays. Therefore, to sustain our environment and society, we must understand the role of an engineer and examine the relationship between them and society. Then, perhaps 21st century engineers can develop a sustainable world in balance with the forces of nature to combat some of the inventible global crises.

Solutions with mechanical engineering

While mechanics are blamed for much of the pollution that contributes to global warming, they may also be the solution. Among the few doable options, the only one that is almost certain to succeed is to reduce our reliance on dirty fuels for energy. However, this can only become a reality if humans begin to use every clean potential energy resource that is available. Many things around us indeed have the potential to meet our energy needs, but lack of technical knowledge keeps us away from taking

advantage of them.

I will use a simple example to explain this perspective. Not known to many, driving a car or riding a bicycle can produce energy. This may appear to be paradoxical, but here is how it works:- When we press the accelerator of a car or pedal a bicycle, energy is applied and the wheels begin to rotate, causing us to move. When wheels begin to rotate, they generate a large amount of angular momentum and kinetic energy. With a simple technique, this energy can be conserved and used to generate electricity. It works in the same way that windmills do. A small generator has to be installed in axial positions inside the vehicle, which should be connected to a battery. As the vehicle moves, the wheels will rotate, causing the turbine inside the generator to spin and generate electricity.

Hence through a very simple technique, we can generate electricity from one of our daily routines. These solutions are not limited, and with proper knowledge, these can be created in many other parts of our routine.

For these solutions to become a reality the role of Mechanical engineering will be crucial. Being a technical field, it can directly impact these discoveries and precise technical capabilities may even boost their productivity. But efforts must be made to avoid the mistakes made by previous engineers. They must revisit their mind set and adopt a new mission statement that contributes towards building more equitable technologies which fulfil demands at various scales and expand the nature of economic growth rather than limiting it.

The mission statement should have a completely different attitude towards natural and cultural systems and reconsider interactions between mechanical disciplines and nontechnical fields.

Some suggested missions that may impact are

1. A major paradigm shift from control of nature to participation with nature
2. An awareness of ecosystems, ecosystems services, and the preservation and restoration of natural capital
3. A new mindset of the mutual enhancement of nature and humans that embraces the principles of sustainable development.
4. Designing system and infrastructure which integrate state of the art technologies into subsequent sustainability and enable information and statistics flow.
5. Analyzing problems to see how mechanical and thermal devices might help solve a particular problem or what changes the design or system as needed.
6. Play leadership roles like working to solve global challenges such as depletion of resources, pollution, ecosystem damage, and the effects of rapid population growth.

If these changes are adopted duly then they may boost the world's Sustainable Development Goals and will contribute to the vast chain of modern production and consumption of natural resources which would deliver services to the larger societies. They will also encourage engineers to find new sources and alternatives for a particular resource that appears to be running out and would embark on a worldwide transition to a more holistic approach to development.

Conclusion

It is clear that a purely environmental approach is insufficient, and hence engineers are required to take a wider perspective including technical and non-technical fields along with goals such as poverty alleviation, social justice, and local and global connections. Sustainable strategies must join hands and work together for a better future. Emerging technologies must be harnessed to gather and ascertain valuable insights to build products that have a lasting positive social and environmental impact along with cost savings and business value. This way forward will support and growth mindsets that allow the engineering community to incorporate sustainability in every solution, product, or service.

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Use of glauconite as a non-reagent sorbent for the softening of drinking and boiler waters, industrial waste water

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ABSTRACT

The article discusses the sorption of purification of water bodies from impurities using natural inorganic sorbents. The availability and low cost of minerals are an important economic advantage of their use for the purification of all types of water. The article describes a method of using an effective sorbent with high ion-exchange and sorption properties for purification of light oil products, for the purification of drinking or industrial water with a high content of heave technogenic metal ions and organic substances. Based on the data obtained, conclusions are drawn about the possibility of using the studied natural mineral sorbents for the extraction of impurities from waste and natural waters.

Keywords: glauconite, alum silicate mineral, sorbent, cation exchange, adsorption, water treatment, industrial wastewater, water hardness, technogenic impurities.

Introduction

In the modern world power supply questions in heat power branch have got a special urgency that is caused by reduction of water resources and an aggravation of ecological loads in environment. Now in the world more than 2 000 000 m3 a day desalted waters is made for the account nonconventional мембранных the technologies, allowing to raise to 30-40% technological efficiency of the steam-power equipment of thermal power plants (TPP). Therefore, carrying out of a complex of actions for the decision of problems energy saving and developments of use nonconventional, безреагентной technologies of water treating are actual. At the same time today, the problem of supply of the population qualitative potable water is in ecological practice of one of the sharpest. The reason of it is the overestimated general rigidity of potable water that can lead to heavy consequences. There is a direct communication between urolithic illness and superfluous rigidity of potable water [1-2].

For today priority research works on working out of technology of improvement of quality of water on water preparatory installation in the conditions of Uzbekistan are carried out, including: perfection of methods of optimization of technological processes of water preparation; installation creation reversible an electrodialysis for restoration of water from drains clarifier for the purpose of returning in

a tower for slag cooling; working out of installation for regeneration cyanides allowing to improve ecological conditions in many regions of the world; working out of installations of sewage treatment containing heavy metals; creation of special installations for residue a brine with recycling of the concentrate, containing mainly salts etc.

In Uzbekistan deterioration of superficial waters because of anthropogenesis pollution is observed. The water problem of region consists that resources of superficial waters practically are completely settled. Underground waters have considerable rigidity and a high mineralization in this connection they are not suitable for use as initial water in work cycles of the industrial enterprises without preliminary desalination. Besides, underground waters have the raised concentration of harmful elements, inadmissible to application under standard requirements for hot water supply (HWS) therefore by water preparation there is a necessity of their removal. The condition of the majority group water conduit morally and physically obsolete because of corrosion damages of pipelines and overgrowth is shown that, that leads to their repeated pollution, high cost of water that is economically unprofitable for objects of industrial and municipal power. Industry development, increase in number of motor transport, water use for needs of agriculture lead to the raised pollution of hydrosphere Work TPPS is connected with consumption of water from natural sources and formation of sewage with the raised maintenance of mineral components.

Dump mineralized and organ-containing sewage in water sources leads to pollution of reservoirs, to deterioration of working conditions of other enterprises consuming water from this source, and also to increase of expenses for water preparation.

Variety of methods and technologies is developed for clearing of industrial sewage, such as flotation, a hyperfiltration, return osmose and others, allowing to reduce anthropogenesis loading on water objects. The final stage in technological processes, as a rule, is additional cleaning of drains with application sorption materials. Therefore, the problem of complex sewage treatment from these elements and organic connections is actual and working out of new sorbents has the big scientific and practical value. Sorption water treating methods are the most perspective and resource saving for water supply and water removal systems. Used sorbents should be simple in operation and possess high technical characteristics.

Quality of sewage from chemical clearings depends on type of the established equipment and an applied method of clearing and is accepted according to the chemical control. In the absence of data of the chemical control the structure of waste waters after their neutralization is applied according to technical and economic indicators (TEI) [2] and tab.1

Table 1: Approximate structure of impurity in sewage from chemical clearings of the equipment on TPPS, mg/dm3

№	Indicator	Methods of chemical clearings						
		Soljano-acid	Integrated	Monoammonium citrate	Phthalic acid	Low molecular acid concentrate	Dicarboxylic acids	Hydrazine acid
1	Chlorides	4500	-	-	-	-	-	-
2	Sulphates	50	400	400	40	40	40	3000
3	Iron the general	5	15	15	10	10	10	5
4	Inhibitors OP-7, OP-10	70	70	70	70	70	70	-
5	Inhibitors PB-5, V-1, V-2	30	-	-	-	-	-	-
6	Kaptaks	-	15	15	15	15	15	-
7	Formaldehyde	200	-	-	-	-	-	-
8	Ammonium connections	500	500	500	280	500	280	280
9	Nitrites	-	250	250	-	250	-	-
10	The dry rest	10000	6000	6000	6000	6000	6000	6000
	The maintenance of organic substances:							
11	Chemical indicator of oxygen, mg O_2/kg	350	1900	1700	3400	3000	2800	-
12	Biochemical indicator of oxygen, mg O_2/kg	180	650	1300	2400	2200	2200	-

In table 2 the structure and concentration of pollution in sewage of Mubarek TPPS are resulted

Table 2: Composition and concentration of pollutants in the wastewater of the Mubarek TPP for the I-quarter of 2019

Indicator	Unit of measure	Norm	January	February	March	Average
Fe	mg/l	0,5	0,073	0,35	0,48	0,301
Cu	mg/l	1,0	0,031	0,43	0,21	0,22
Cl	mg/l	350	44	156	120	116
The weighed substances	mg/l	30	0,17	0,24	0,56	0,32
Mineralization	mg/l	1000	365	720	424	500
NO_2	mg/l	45	0,068	1,02	0,44	0,509
NH_3	mg/l	2,0	0,84	0,64	0,04	0,506
SO_4	mg/l	500	7,4	10,3	12,4	10,0
Mineral oil	mg/l	0,3	0,118	0,166	0,11	0,13

With a view of reduction of dumps of sewage and accordingly a fence of fresh water it is recommended at stations below-mentioned actions:

Reduction of a fence of fresh water for feed of turnaround system of cooling at the expense of use for this purpose weakly mineralized sewage from other systems TPP after their preliminary clearing. Drains concern such waters from water washing of the coppers, loosening and flushing waters of filters water preparatory installation, blowing-off waters of coppers, a condensate returned with fuel oil, water

after cooling of bearings of rotating mechanisms and other Petro containing drains after their clearing of mineral oil rain and thawed snow from territory TPPS;

Use for ashes and slag washout in system hydro ash catcher (SAC) of sewage from other systems TPP in exchange fresh water. For these purposes it is expedient to use salt drains water preparatory installation, blowing-off water of turnaround system of cooling, water after chemical clearings of the equipment, hydro cleaning of premises, etc.

The reuse organization on the water-preparatory device (WPD) sewage, both own, and other technological systems, clarifiers, loosening and process waters of filters it is expedient to use blowing-off waters as initial water, and the fulfilled reclaiming solutions to use for repeated regeneration. As initial water on food WPD is admissible to use weakly mineralized drains of other technological systems after their preliminary clearing if that it is necessary, etc.

For sewage treatment the big interest is represented by natural sorbents which concerns glauconite. Essential advantages of this mineral are: the wide circulation, cheapness, availability, granular structure, thermal stability, good ion exchange and filtration properties, and also possibility by chemical and structural modifying directed to change technological indicators of a mineral [3].

Glauconite - natural alum silicates with the general formula

(K, H2O) (Fe3+, Al, Fe2+, Mg)2 [Si3 AlO10] (OH)2 *n H2O [4]. Glaukos (γλαυκός) - on it is Greek "aeruginosa", a mineral of group of hydromicas of a subclass of layered silicates widespread in sedimentary breeds, autogenic monoprismatic a mineral from group alum silicates, possessing high absorptions and cations-exchange properties. Rather widespread in some deposits of a sea origin. Maintenances of the main components in typical glauconite fluctuate in following limits (in%): Potassium oxide (K2O) - 4,0 ÷ 9,5; oxide sodium (Na2O) - 0 ÷ 3,5; oxide aluminum (AL2O3) - 5,5 ÷ 22,6; Iron trioxide (Fe2O3) - 6,1 ÷ 27,9; Iron oxide (FeO) - 0,8 ÷ 8,6; oxide magnesium (MgO) - 2,4 ÷ 4,5; silicon dioxide (SiO2) - 47,6 ÷ 52,9; water (H2O) - 4,9 ÷ 13,5. In the form of impurity are present: CaO to 1% (higher maintenances are usually connected with CO2 in the form of a carbonate), sometimes P2O5, B2O3, etc. [5].

Glauconite possesses enough high ability to cationic to an exchange, then and it is caused its uses for the industrial purposes. Increase of productivity of soil, land improvement, manufacture of organon-mineral fertilizers, improvement and restoration of soils, sewage treatment, catching of gases, elimination of smells, neutralization of floods of mineral oil, sorption heavy metals, radionuclides and toxicants can be used in such processes as water purifications drinking and a process water, sorption and dehydration of mineral oil, clearing and regeneration of power oils, preparation of water for steam and gas generators and boilers, as the fodder additive in animal industries, poultry farming, fish culture. Such application is based on its ability to reactions cations an exchange. For these purposes glauconites concentrates are preliminary processed by a table salt solution therefore sodium ions are absorbed by a

concentrate. At filtering through such concentrate of hard water there is an exchange cation: alkaline earth cation waters are absorbed, and in a solution pass cation sodium, then and decrease in rigidity of water is caused.

High efficiency glauconite is established at clarification of water from salts of heavy metals, of some organic and inorganic structures, radionuclides [5]. Activated glauconite at a filtration through it of the polluted waters practically completely detains iron and ammonia structure, almost 10 times lowers contained in water of mineral oil, at 20-25 time lowers contents of radioactive isotopes of caesium-137 and strontium-90. High adsorptions and cation exchange properties glauconite can be used not only in quality adsorption heavy metals, oil sludge, polluting water objects and soil, and also for liquidation of the pollution which are in deposits of treatment facilities and industrial drains, in ground and water objects, by means of the vulgar entering and creation of geochemical barriers. Glauconite it is applied at rehabilitation of the territories amazed radionuclides or having high technogenic loading as a result of activity of the industrial enterprises. It is effectively used in rural, a national economy and the industry for neutralization of floods of mineral oil, clearing and restoration of soils, catching of gases, sewage treatment, sorption heavy metals, toxicants, radionuclides. It is an irreplaceable resource for reclamation dumps municipal solid waste (MSW) as it catches landfill gases and does not give them to more environment.

It is revealed [6], that clay breeds possess a high measure chemical inertia or protective properties of the equilibrium condition established in them that proves to be true presence in them of some buffer action factors. Collodion-disperse minerals concern major of them, sparingly soluble salts of the basic or acid character, structure exchange cations and anions, a parity in ashes-gel to a phase acidosis and basoids, the maintenance humus substances etc. Besides, is important for noticing, that clay and clay breeds steadily exist in rather narrow area pH, from 5 to 5,8 - two-layer fluosilicates - kaolinite, allofan, galluasit and from 6,5 to 8 - biotite, muscovite, glauconite, montmorillonite, illit, chlorite, etc.

Therefore, at entering into Wednesday (ground, waters) alum silicate, capable to displace reaction of environment for limits of area of steady existence of clay minerals of breed, it will be subject to intensive hydrolysis. However, to the beginning of realization of such destructive process counteracts buffer action factors. But, as glauconite that is difficult mineral system, according to principle Le-Shatele, it renders braking counteraction adverse for its steady condition to change of reaction of environment. Therefore, factors of buffer action of clay breeds are as though primary means of maintenance of processes of self-organizing at protection of the generated structural structure of clay breed or a primary stage specified above braking counteraction. If aggressive influence of chemical reagents completely overcomes action of factors of buffer action of breed (i.e. suppresses them) counteraction to these processes is carried out at the expense of buffer action of crystal lattices of the basic mineral, in our case GLAUCONITE.

In particular, from its crystal lattices is extracted those oxides which are capable to render neutralized counteraction to ions of the chemical reagent which has caused adverse changes pH of environment.

Sorption substances glauconite - the multiphasic process directly depending on porosity of a sorbent and backlashes between contacting particles. Glauconite it is characterized by an active absorbing surface and presence of functional groups (silanols, silicanes, etc.), capable to connect ions of the various nature [7].

According to [8], possibility sorption softening drinking and boiler water of installations of an average and a high pressure with concentrate use glauconite as a sorbent with its finishing to standard requirements, accordingly, 7 and 0,10 mmol-ekv/l is considered. Maximum sorption it is reached in 20-40 minutes from the process beginning. Thus the general initial rigidity of potable water decreases on 3540%, and boiler water at two-cyclic clearing on magnesium on 96%, on calcium almost on 100%.

One of important and a challenge, at softening the natural waters arriving for household needs from artesian water fences and superficial sources, is, absence cheap under the cost price and accessible sorbents. To consider as base synthetic products, including various cations, for these purposes it is unpromising. The matter is that scale softening such waters demands huge weight cationic, considerably exceeding their existing manufacture. From here and inevitable deficiency. Besides, synthetic cations are insufficiently studied in relation to softening the waters comparable and even essentially exceeding concentration sulphate, nitrate and a hydro carbonate of ions in comparison with the maintenance cations rigidity. It is known, that in a basis cation an exchange at softening waters lay following processes [9]:

sorption;

regeneration;

loosening.

As a whole, regeneration very dirty process [10] generating great volume highly mineralized of drains, demanding, in turn expensive regeneration. And, since strongly acidic cations as sorbents meet rather widely it should be recycled their big enough weights, creating essential volumes of sewage. Hence, it is expedient to replace these sorbents also with others which can be utilized economically expediently, not resorting to regeneration. It is a serious ecological problem.

With specified questions deep softening the waters, being as it was already marked, are socially-environmental problems closely connected by one of the reasons of high expenses also at use of heat of boiler installations. It is a question, first of all, of the water directed on a food of coppers of a high pressure. Special demands are made to such water [11-17] in general. For similar devices with natural cooling the feedwater should meet following standard requirements:

The general rigidity no more: - For gas pipe and fire tube the coppers working on firm fuel, - 0,5 mmol-ekv/l; - For gas pipe and fire tube the coppers working on gaseous or liquid fuel, - 0,03 mmol-ekv/l; -For water trumpet coppers with working pressure 13 <P <39 kgs/sm3 - 0,015 mmol-ekv/l.

Let's preliminary notice, that the scum represents averages and basic salts Ca (II) and Mg (II)-CaCO3, Mg CO3 [9/12], [Mg4 (CO3) 3 (OH)-9H2O [18].

Naturally, formed components of a scum essentially differs on properties. So, for example, solubility CaCO3 decreases with temperature growth, and speed of adjournment of a carbonate of calcium, owing to a number of its features, should not exceed 0,25 g / (m2*h). It was one of the basic requirements to the water spent for feed of turnaround systems, connected with restrictions on its rigidity.

Existing numerous methods of water treating from cations rigidity [11-13], of course, differentiated by efficiency concerning scum components. Deep softening waters can be reached by means of two phasic osmose with the subsequent tap permeate on decarbonization and definitive demineralization in filters of the mixed action [18]. But such approach conducts to essential increase of the cost price of a heat supply of the population, expenses on which constantly grow, strengthening social and economic intensity. However, turnaround water goes not only in heat exchange turnaround systems. It is spent in technological and power processes. In this case its rigidity should be less, than in systems of turnaround water supply - the maintenance of salts no more than 10 … 15 mg/l, rigidity <0,020 mmolekv/l [19] is more exact.

Expediently widely to use natural sorbents for the decision of problems softening waters as complex method of protection of environment by means of volume decrease high mineralized drains and improvement of health of the population, reduction of social and economic intensity. In this respect is available also defined, though and the extremely limited experience. One of natural sorbents - glauconite, meeting in powerful superficial deposits, practically does not lose the properties at hour action with hydrochloric acid (Hcl). According to [20], application clinoptilolite sorbents at water treating under the scheme: chlorination → ozonation → contact coagulation leads to essential decrease in its chromaticity and turbidity. In [20], it is informed on 10-fold use bentonite for water treating from finely dispersed oil and mineral oil with stage-by-stage washing a sorbent ligroin and regeneration in special furnaces. It is used for this purpose natural sorbents in the USA [20]. In Japan on base alum silicates the sorbent for removal Cd (II) and Cr (II) of sewage is received. At the industrial enterprises of the USA, France, Japan the mix montmorillonite and poligorskite is with that end in view used. Thus, search and research are necessary for the decision listed above problems of protection of a surrounding environment and population health physical and chemical and sorption characteristics of ecologically pure natural sorbent accessible on volume which extraction is possible in the open way. The similar sorbent should have deposits in various regions of the country, allow to lower to standard indicators rigidity of potable water on installations of various productivity and in volumes, sufficient for satisfaction of requirement of the population of the big and small cities. Use of such sorbent as follows from stated, should allow is essential to lower volumes high mineralized sewage or them completely to eliminate, reduce the price of logistics. The sorbent should work effectively in the presence of

considerable concentration (1-10 mmol/l) anions SO42 - NO-3, HCO-3, HSO4 - commensurable or exceeding the maintenance cations rigidity (Ca (II), Mg (II)), present in artesian or superficial water. Thus, softening waters it should be possible over a wide range according to technological problems, and the fulfilled sorbent - to suppose economically and toxicologically expedient recycling.

In Republic Uzbekistan bowels the considerable quantity of various kinds of the minerals which use promotes development of economy of the state [21] is concentrated. These minerals represent a raw-material base for production, best-selling in the internal and world markets. In the glauconite Uzbekistan it is developed in sandyargillaceous adjournment of the Gissar range, ZiaetdinZirabulak mountains, Kizilkum raisings, Sultaunizdag, and also in Northern Fergana and in Tashkent geological area, deposits glauconite sandstones - Kofrun, Chang, Aksu, Bolgali, Tagarasay and Mobika also are revealed. Qualities glauconite sandstones on displays Krantau have been studied. Besides deposits 17 perspective displays [22] are revealed.

It is established, that glauconite sand from deposits Krantau contains basically glauconite, quartz, anorthite, feldspar, illite, muscovite and galite.

Presence in Uzbekistan a large Krantau deposit glauconite, does actual working out on its basis of sorbents, suitable to use as loading of filtering constructions for sewage treatment from technogenic impurity on industrial productions.

The chemical compound glauconite from deposits Krantau is characterized by following data (%) [22]: SiO2 - 70,27; AL2O3 - 9,95; Fe2O3 - 4,95; K2O-3,08; Na2O-2,46; CaO0,80; MgO - 0,99; MnO - 0,05; TiO2 - 0,49; P2O5-0,10; SO3 - 0,72. In mineral structure glauconite breeds of the Krantau deposit presence of 35 minerals is established.

The capacity cations a concentrate exchange glauconite changes from 390 to 550 mg-ekv, natural glauconite the Krantau (ore) - to 250 - 300 mg- ekv on 1 kg of ore. The mineral possesses ability of selective absorption cationic and long-living radioisotopes. Limiting absorbing ability glauconite in relation to heavy metals looks belowmentioned image: on copper - 781,2; on nickel - 342,4; on zinc - 827,7; on gland - 1317,8 mg-ekv. on 1 kg of a mineral. Ability glauconite to take heavy metals from solutions makes (in% from the initial maintenance): Pb - 99, Hg - 64, Co - 97, Cu - 96, Mn - 95, Cr - 92, Ni - 90, Zn - 90, Fe - 99.

Glauconite is a qualitative water softener, the good pigment of green color proof to atmospheric influences, and also adsorptions, on quality not conceding using now at processing of mineral oil and clearings of industrial sewage. Glauconite also is of interest at clearing of radioactive drains. Possessing high sorption in capacity to radioactive salts, glauconite the filter after processing easily conglomerates in vitreous weight in which radioactive salts pass in an insoluble condition that facilitates a burial place of the fulfilled filters. The additive glauconite in cement as filler promotes reception of the concrete interfering penetration both rigid, and soft radioactive radiation. Despite the

specified merits glauconite, its practical use till now the insignificant. The developed requirements of the industry to glauconite to raw materials are absent now. Breeds with rather high maintenances glauconite (more than 25-30%), apparently, can be used in a natural kind, and breed with the smaller maintenance glauconite demands enrichment.

It is necessary to notice, that works on application glauconite the Kofrun, Changi, Aksu and Mabik deposits in clearing processes, additional cleanings are more exact, some water, in Uzbekistan was not spent. Therefore, samples glauconite the Krantau deposit for clearing drinking water and sewage of Mubarek TPP have been investigated.

Researches of structural-morphological features, physical and chemical are carried out, ion exchange characteristics glauconite the given deposit show possibility of its application in water preparation schemes. The basic physical and chemical indicators glauconite the Krantau deposit are resulted in table 3.

Table 3: The basic physical and chemical indicators glauconite

Specific surface on BET method, m2/g	Volume pores, sm^3/g		
	micro	mezo	the total
20,56	0,0027	0,026	0,033

Preliminary in water the maintenance of investigated ions has been defined. Concentration of the general iron it is defined by a photometric method on device FEK-2 with sulfosalt acid, cations calcium and magnesium - complexometric titration Trillon B from indicators eriochrome black T, sulphate-anions - turbidimetric a method, chlorides-ions - titration by nitrate silver in the presence of the catalyst chromic acid kalium. Qualification reactants clean for analysis are used. Initial water was passed through ion exchange a column filled with the investigated sorbent, water was filtered and in a filtrate are made definition cations Ca2 +, Mg2 +, Fe2 + and Fe3 + and anions Cl - So42.

Table 4: Results sorption ions glauconite according to the chemical analysis

№	Investigated ions	Mass fraction absorbed adsorbate,%
1	Fe^{2+} и Fe^{3+}	30,2
2	Ca^{2+}	79,8
3	Mg^{2+}	76,8
4	Cl^{-}	70,9
5	SO_4^{2-}	68,4

According to the received data, glauconite the Krantau deposit it is effective sorb ions Ca2 +, Mg2 +, Cl - SO42 - to a lesser degree cations gland and also, rigidity decrease, for the account sorb abilities of a mineral, has averaged 78%.

Studying kinetics only ions Fe2 + has shown adsorptions, that absorption of these cations Krantau glauconite makes 6570% and is reached for 30-45 minutes. Research of adsorption of ions Fe2 + was spent by a method of measurement of kinetic curves in stationary conditions. For this purpose, hitch adsorption by weight 2 grammes it was maintained in 250 ml to the distilled water in a current 24 hours. After decanting adsorbent in a damp condition, it was filled in just done with solution FeSO4 * 7H2O with the maintenance cations Fe2 + 21±1 mg/l (in the ratio 2 g a sorbent and 100 ml of a solution). Sorption cations it was spent at continuous hashing by a mixer in a current of 45 minutes. Through each certain time were selected and tests X-ray fluorescence on a method calibration a curve was analyzed by way. On the basis of the received data calculation of equilibrium concentration of ions Fe2 + (Cp) and their adsorptions (G) was carried out In table 5 and on fig. 1 results sorption ions Fe2 + glauconite the Krantau deposit are presented.

Table 5: Results of adsorption glauconite ions Fe2 + in time

№	t, minuts	Cp, mg/liter	$G*10^9$, mg/sm^2
1	0	0	0
2	5	15,97	3,87
3	15	13,1	4,12
4	30	6,01	7,46
5	40	5,81	7,66
6	60	5,92	7,54

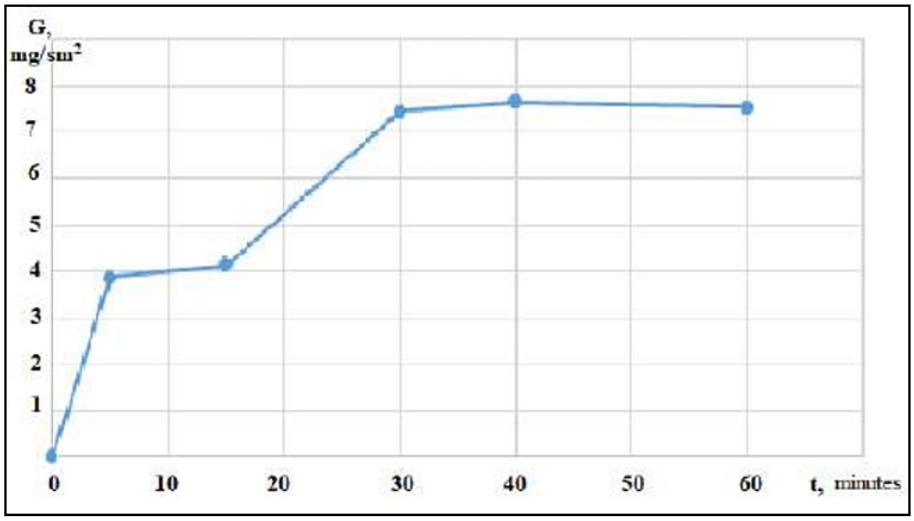

Fig 1: The dependence of the adsorption of Fe2+ ions by Krantau glauconite on time.

Ariphmetic mean values from five measurements are used.

The obtained experimental data indicate that sorption equilibrium is achieved in 30 – 40 minutes. The concentration of sorbet Fe2+ glauconite cations under equilibrium is 15,97 mg/l or about 73 mass.% of the initial value.

As shown by the analysis of samples of drinking water and industrial effluents from Mubarek TPP that passed through such an experimental installation, its properties after water treatment are significantly improved. Further development in this direction is the search for new variants of sorbents with high technological and sorption properties that can be used to treat highly concentrated industrial wastewater.

Analyzing the experimental data, we can draw the following conclusions

1) Glauconite of the Krantau deposit has a high sorption with respect to non Ca2+, Mg2+, Cl-, SO42-, which makes it possible to use it as a natural water softener in water treatment processes;

2) The adsorption of Fe2+ ions by glauconite is 70 – 73%, while the adsorption of Fe2+ and Fe3+ ions together from tap water is only 30,2%, which is probably due, under certain conditions, to the release of Fe3+ ions from the ionize crystal lattice.

3) The conducted studies are relevant for the use of glauconite as sorbents in water treatment processes.

4) Sorbent allows you to purify water from a large number of inorganic and organic and compounds at minimal cost.

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A novel algorithm to monitor process mean and process capability index for a dynamic target

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ABSTRACT

In this article, a novel algorithm is introduced to monitor the process mean and a novel process capability index is developed for a normal production process. The new process capability index is able to deduct the capability of the process more accurately. An illustration is given for turning operations carried out in CNC machining centre. The work piece material used in the turning process is AISI 304 stainless steel. The process parameters used in the turning operations are 200 m/min cutting speed, 0.05 mm feed rate and 0.5 mm depth of cut. It is found that the new index is robust and can give warning if the spread is more in the process. It is found that when the mean is in the dynamic target, the process spread shows few warnings through the control charts. From the process capability analysis, it is found that the Cpk is less than one for the observed data. This shows that the process is not adequate of meeting the required dynamic target. Where as the newly developed algorithm is capable of meeting the required capability. Hence it is advisable to utilize CTpk to prevent future non-conformities.

Keywords: stainless steel, turning, process mean, monitor, capability index, dynamic target

Introduction

The process capability index gives the relationship of process specification and actual performance of the process. There are several process capability indices such as Cpk, Cr, Cp, Cpm etc. The process capability index is applicable to variable quality characteristics. It is a quantitative measure that reflects how well the process can produce components for the given standard or specification.

The process capability index is developed by Juran (1974) [6] and is defined as $Cp = (U-L)/6\sigma$, that does not depend on process mean. A new process capability index focused on the target value known to be Cpm is developed by Chan et al. (1988) [1]. Grant, E.L., and R.S. Leavenworth (1996) [3], have given the metrics for process capability indices. One can find a detailed study of process capability analysis in Montgomery, D.C (1996) [10]. Comparisons among various indices and its confidence intervals can be found in Mark L. Crossley (2010) [8]. Many authors have contributed to the development of process capability indices. The Cpk is introduced by Kane (1986) [7] to study the impact of process mean μ on the process capability indices. Hsiang and Taguchi (1985), considered the

influence of the departure of the process mean (μ) from the target T. Yerriswamy Wooluru et al. (2014), have studied the process capability tools and techniques. Mohamed Boujelbene (2018) [9], has studied average roughness through process capability tools. Parvesh Kumar Rajvanshi and R.M. Belokar (2012) [11], have improved the boring operation through process capability tools. Gabriele Arcidiacono and Stefano Nuzzi (2017) [2] have reviewed the fundamentals of process capability ratio. Joseph KA (2017) [5], has studied process stability of the moulding machine. The cpk process capability index is the minimum of Cpu, Cpl. The International Standard of Cpk is 1.33. If the production process turns out more than 1.33 as Cpk value, then the process potential is upto International standard. In industries Shewhart Variable Control Chart is widely used to monitor the process mean. But due to several factors the target may be changed. Hence to incorporate the dynamic target appropriate algorithm is needed. However, there is a research gap in developing control charts and process capability indices for dynamic target. Hence a novel algorithm is developed in this article and accordingly the process capability index Cpk is modified.

Turning process details

The work piece material used in the turning process is AISI 304 stainless steel. The turning process is carried out in Batliboi make CNC machining centre. The diameter and length of the workpiece used in the turning operations are 40 mm and 100 mm, respectively. The process parameters used in the turning operations are 200 m/min cutting speed (v), 0.05 mm feed rate (f) and 0.5 mm depth of cut (d). The chemical composition of the AISI 304 stainless steel is shown in Table 1.

Table 1: Chemical composition of the AISI 304 stainless steel (weight %)

Element	C	Mn	Si	P	S	Cr	Mo	Ni	Fe
%	0.069	1.63	0.4090	0.0420	0.0110	18.5	0.29	8.02	70.1

Measures of Process Capability for a target mean

1. $C_{pu} = \frac{(USL - \bar{X})}{3\sigma}$
2. $C_{pl} = \frac{(\bar{X} - LSL)}{3\sigma}$
3. $C_{pk} = \min (C_{pu}, C_{pl})$.

Where, USL= Upper Specification Limit.

LSL=Lower Specification Limit.

σ= Process standard deviation.

A novel algorithm for and R chart

Step 1: Draw a sample from the production process and arrange it in subgroups.

Step 2: Determine the median for each subgroups. This is the new dynamic target.

Step 3: Truncate left and right observations from the target median or smooth the data by replacing all the values that exceeds the new target by median value.

Step 4: Now find the sample mean and .

Step 5: Obtain Upper Control Limit and Lower Control Limit.

Step 6: Plot and R chart and if any point falls beyond UCL or LCL, the process is said to be out of control. Otherwise the process is said to be in Statistical Quality Control.

Step 7: Determine Process Capability Index Cpk, if Cpk. 1.33, the process is capable of producing items according to international standard otherwise it shows incapable of the process. Hence remedial action is asked.

Measures of process capability indices for a dynamic target

The New Process Capability Indices based on dynamic target are given below:

1. $C^{T}_{pu} = \frac{(USL - \bar{X}_T)}{3\sigma}$

2. $C^{T}_{pl} = \frac{(\bar{X}_T - LSL)}{3\sigma}$

3. $C^{T}_{pk} = \min (C^{T}_{pu}, C^{T}_{pl})$.

Where, USL= Upper Specification Limit.

LSL=Lower Specification Limit.

σ= Standard deviation based on the target.

T = Dynamic target mean based on the target.

CTpu Process capability index for the upper specification

limit based on the target.

CTpl Process capability index for the lower specification

limit based on the target.

$C^{T}_{pk} = \min (C^{T}_{pu}, C^{T}_{pl})$.

Table 2: Observed data for turning operation of cylindrical components in a CNC Turning center (Diameters in Millimeters) Drawing Size = Diameter ⌀38 ± 0.02 mm

Exp. No.	X_1	X_2	X_3	X_4
1	38.00	38.01	38.01	38.00
2	38.00	38.00	37.99	37.99
3	38.00	37.99	38.00	37.99
4	38.01	38.00	38.00	38.01
5	38.01	38.01	38.00	38.00
6	38.01	38.00	38.00	38.01
7	38.00	37.99	37.99	38.00
8	38.01	38.01	38.00	38.00
9	37.99	37.99	38.00	38.01
10	38.01	38.01	38.00	37.99
11	38.01	38.00	38.01	38.00
12	37.99	38.00	38.00	37.99
13	37.99	37.99	37.99	38.00
14	38.00	38.00	38.00	37.99
15	38.01	38.00	38.00	37.99
16	37.99	38.00	38.01	37.99
17	38.00	37.99	38.00	38.00
18	38.00	38.01	38.00	37.99
19	38.01	38.00	38.00	38.01
20	38.00	37.99	37.99	38.00

Fig 1(A): Machined work piece (B) Diameter measurement using micrometer

Table 3: Descriptive Statistics for the known variables before smoothing

Sample	N	Mean	SE Mean	TrMean	StDev	Minimum	Q1	Median
X1	20	38.002	0.00172	38.002	0.00768	37.990	38.000	38.000
X2	20	37.999	0.00170	37.999	0.00759	37.990	37.990	38.000
X3	20	37.999	0.00135	37.999	0.00605	37.990	38.000	38.000
X4	20	37.998	0.00172	37.998	0.00768	37.990	37.990	38.000

Table 3 shows the descriptive statistics for the experimental data before smoothing. Table 4 shows the descriptive statistics for the smoothed data by using new algorithm.

Table 4: Descriptive Statistics for the known variable X by using new algorithm

Sample	N	Mean	SE Mean	TrMean	StDev	Minimum	Q1	Median
X1	20	37.998	0.000918	37.998	0.00410	37.990	38.000	38.000
X2	20	37.997	0.00105	37.997	0.00470	37.990	37.990	38.000
X3	20	37.998	0.000918	37.998	0.00410	37.990	38.000	38.000
X4	20	37.996	0.00112	37.996	0.00503	37.990	37.990	38.000

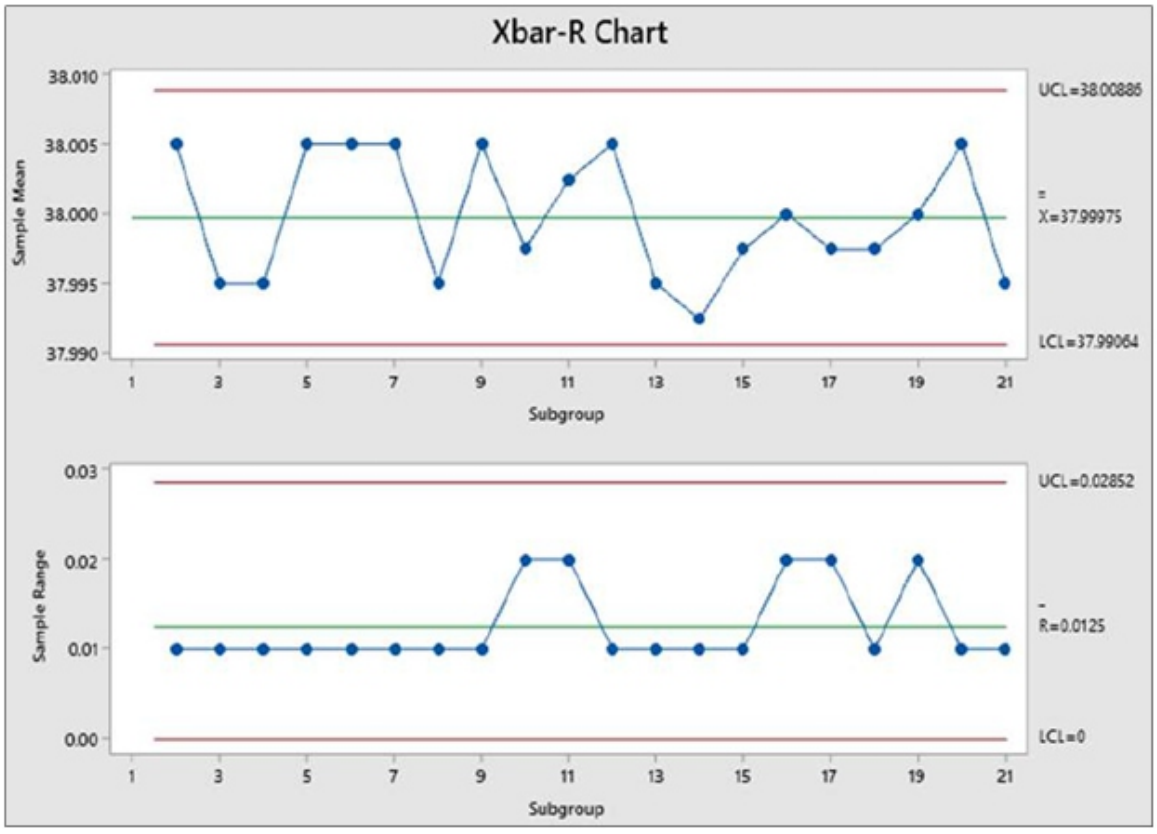

Fig 2: X and R chart for the observed sample data using Shewhart algorithm

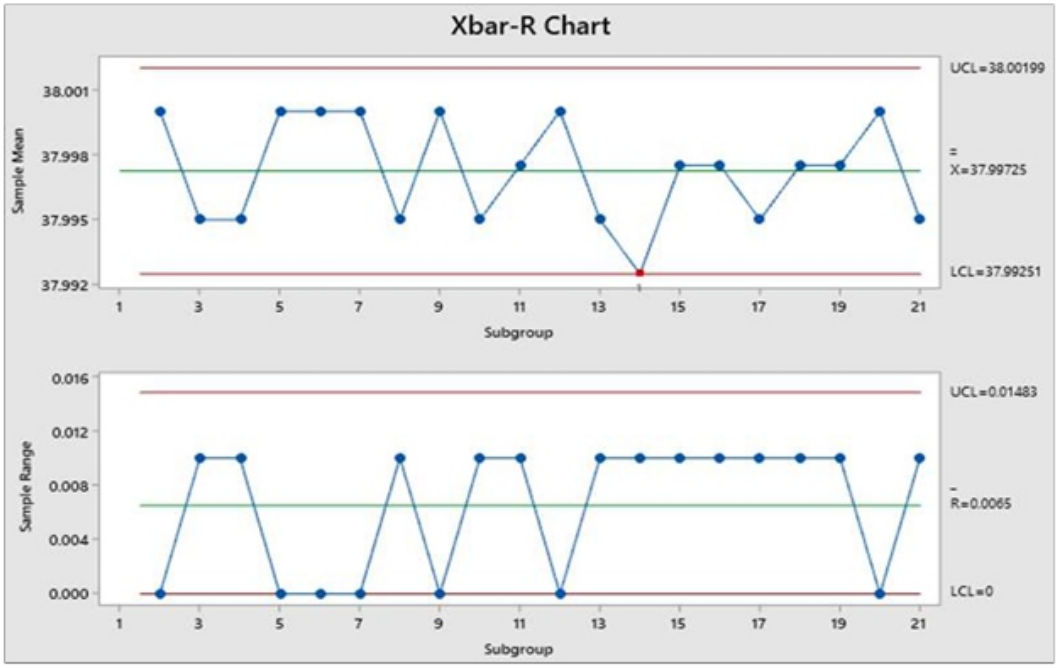

Fig 3: X and R chart for the Modified algorithm

Interpretation: Figure 2 shows the and R chart for the observed sample data using Shewhart algorithm. From the figure 2, it is found that the production process is in Statistical Quality Control. It reveals that the process is governed only by the natural variances. Figure 2 shows the and R chart for the Modified algorithm. However if the dynamic target changes then the control charts are changed as in figure 3, that reveals a warning. Hence appropriate action is sought. This may help the quality control practitioners to avoid future non-conformities.

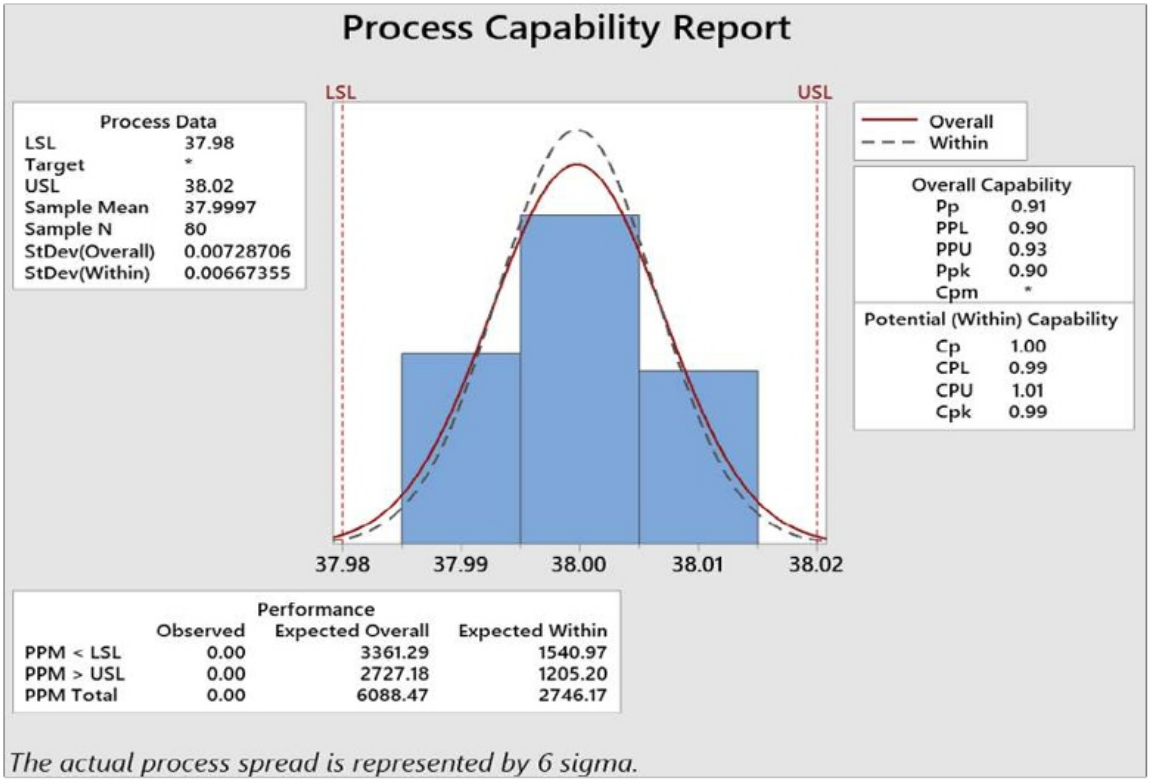

Fig 4: Process capability values for the observed data

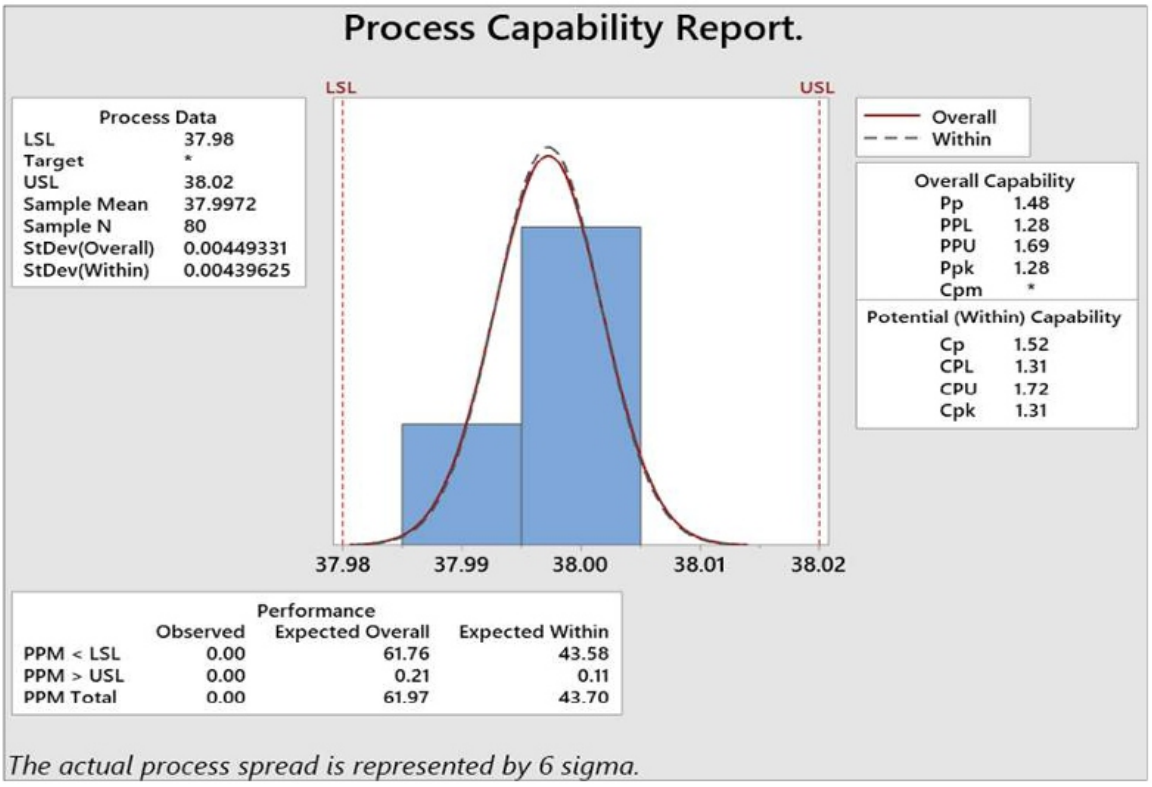

Fig 5: Process capability indices values based on the novel algorithm

Interpretations Fig 4, shows the process capability values for the observed data based on Shewhart algorithm. It is found that the process capability values are lower than one. Hence we conclude that the production process is not capable of producing items. Therefore, in order to achieve the capability of the process the dynamic target algorithm is recommended. Figure 5, shows the process capability indices values based on the novel algorithm Hence from figure 5, it is also found that the novel algorithm for and R chart reveals the process is capable of producing according to International standard.

Confidence interval for the process capability index Cpk

Let

n = Sample size

Cpk = Process capability index

Zα/2 = Two- sided normal standardize value.

The upper tail confidence interval for Cpk is

$$C_{pk} + Z_{\alpha/2}\sqrt{\frac{1}{9n} + \frac{(Cpk)^2}{2n-2}}$$

The upper tail confidence interval for the dynamic target process capability index CTpk is

$$C^{T}_{pk} + Z_{\alpha/2}\sqrt{\frac{1}{9n} + \frac{(CTpk)^2}{2n-2}}$$

Table 5: Comparison of Confidence Intervals for Cpk and CT pk

	Value	Upper Limit
$C_{pk}=$	0.99	2.236788714
$C^{T}_{pk}=$	1.3	3.947411146

From table 5, it is found that the upper limit reaches nearly four in case of newly developed process capability index Ctpk

Conclusion

The process capability studies in turning process of AISI 304 stainless steel is carried out sues fully. Due to several factors in the quality control environment, the target may be changed. Hence to incorporate the dynamic target appropriate algorithm is developed. The novel algorithm is capable of revealing the warnings in the control charts. The new algorithm is used to modify the process capability index Cpk.

The newly introduced process capability index may be used in the industries for future purpose in order to achieve the international standard of the capability of the process.

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