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Aims and Scope

Journal of Industrial and Mechanical Engineering is a peer-reviewed journal for the presentation of original contributions and the exchange of knowledge and experience on mechanical and industrial engineering topics like Acoustics and Noise Control, Aerodynamics, Agricultural machinery, Applied Mechanics, Automation, Mechatronics and Robotics, Automobiles, Automotive Engineering, Ballistics, Biomechanics, Biomedical Engineering, Composite and Smart Materials, Composite Materials, Compressible Flows, Computational Mechanics, Computational Techniques, Dynamical Analyses, Dynamics and Vibration, Energy Engineering and Management, Engineering Materials, Fatigue and Fracture, Fluid Dynamics, Fluid Mechanics and Machinery etc.

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Contents

Study of Lean Manufacturing Philosophy in Gear Manufacturing Company

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ABSTRACT

U.S. manufacturers have always searched for efficiency strategies that help reduce costs, improve output, establish competitive position, and increase market share. Early process oriented mass production manufacturing methods common before World War II shifted afterwards to the results-oriented, output-focused, production systems that control most of today's manufacturing businesses- Lean is simply about creating more value for customers by eliminating activities that are considered waste. Any activity or process that consume resources, adds cost or time without creating value becomes the target for elimination. Lean Manufacturing is a systematic approach to identifying and eliminating waste through continuous improvement. Lean is about doing more with less: Less time, inventory, space, people, and money. Lean is about speed and getting it right the first time. From an operations perspective, Lean is helpful in cutting production cuts costs & inventories rapidly to free cash, which is critical in a slow economy. It also supports growth by improving productivity and quality, reducing lead times and freeing huge amounts of resources. Lean manufacturing is a technique, which, by focusing on the overall picture and waste reduction and removal programs creates higher stocks and increases the bottom line profits. It is among one of the few programs that cover its impact on such a vast group. Lean manufacturing has its effect on the employees and the customers alike.

Keywords: Reduces the cycle time, Socially answerable techniques, Focuses on waste reduction, avoidance, removal of waste, reduced cycle length.

1. INTRODUCTION

Lean Manufacturing is a systematic approach to identifying and eliminating waste through continuous improvement. Lean is about doing more with less: Less time, inventory, space, people, and money. Lean is about speed and getting it right the first time. Lean production is aimed at the elimination of waste in every area of production including customer relations, product design, supplier networks and factory management. Its goal is to incorporate less human effort, less inventory, less time to develop products, and less space to become highly responsive to customer demand while producing top quality products in the most efficient and economical manner possible. Lean is a mindset, or way of thinking, with a commitment to achieve a totally waste-free operation that's focused on our customer's success. It is achieved by simplifying and continuously improving all processes and relationships in an environment of trust, respect and full employee involvement. It is about people, simplicity, flow, visibility, partnerships and true value as perceived by the customer. . But lean manufacturing questions the role of inventory and defines as a waste it self and also as the reflector of the imperfections a system has. This example, itself shows the conceptual deference between the traditional manufacturing system and lean manufacturing system.

2. METHODS TO IMPLEMENT LEAN

While most of these lean methods are interrelated and can occur concurrently, their implementation is often sequenced in the order they are presented below. Most organizations begin by implementing lean techniques in a particular production area or at a “pilot” facility, and then expand use of the methods over time. Companies typically tailor these methods to address their own unique needs and circumstances, although the methods generally remain similar. In doing so, they may develop their own terminology around the various methods. There are numerous methods and tools that organizations use to implement lean production systems. Eight core lean methods are described below:

1) Kaizen
2) 5S
3) Just-in-time Production
4) Total Productive Maintenance (TPM)
5) Cellular Manufacturing / One-piece Flow Production Systems
6) Kanban
7) Six Sigma
8) Pre-Production Planning (3P)

2.1.2 Method Description

2.2.1 Kaizen

Kaizen, a Japanese term that basically translates to 'continuous improvement' or 'change to become good', is a management concept originated by the Japanese in order to continuously effect incremental changes for the better, involving everybody within the organization from workers to managers. Kaizen is aimed at producing more and more value with less and less wastes (higher efficiency), attaining better working environment, and developing stable processes by standardization.

2.2.2 5S

5S is a Japanese methodology for workplace organization. As the name implies, it is a five- step technique for changing the mindsets of the staff and involving the entire organization in improvements. To some, this methodology may appear to be a housekeeping approach, but it actually delivers much more. The 5S concept was popularized by Taiichi Ohno, who designed the Toyota Production System, and Shigeo Shingo, the Japanese practitioner who put forward the concept of poka-yoke. When Japanese organizations embark on a quality journey, typically they commence with 5S deployment and then move on to higher methodologies. In the manufacturing World, 5S is used as a housekeeping tool while deploying Total 5S is an approach to quality improvement that can take an organization to new heights when implemented effectively. Simple and immensely practical, this methodology can transform the fabric of a company.

2.2.3 Just In Time Production

Just in Time (JIT) is the backbone of the lean manufacturing system. Initially Toyota production system is known as the JIT system due to this reason. All the basic concepts which lately became lean manufacturing developed in Toyota for this system. For an example, concept of producing things when they need, pull scheduling and kanban are few things developed here. [16]

Initially JIT aimed at manufacturing process improvement. Therefore even today people call JIT as JIT manufacturing. But actually JIT consist of three main parts. They are known as JIT purchasing, JIT manufacturing and JIT distribution.

2.2.4 Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is an initiative for optimizing the effectiveness of manufacturing equipment. TPM is team-based productive maintenance and involves every level and function in the organization, from top executives to the shop floor. The goal of TPM is "profitable PM." This requires you to not only prevent breakdowns and defects, but to do so in ways that are efficient and economical. To achieve this goal we will need to master five techniques-

1. Preventive maintenance - It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

2. Periodic maintenance (Time based maintenance - TBM) - Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.

3. Predictive maintenance-This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

4. Corrective maintenance -It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability

5. Maintenance prevention - It indicates the design of new equipment. Weakness of current machines are sufficiently studied (on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing) and are incorporated before commissioning a new equipment. Breakdown maintenance repairing after breakdowns occurs.

2.2.5 Cellular Manufacturing / One-piece Flow Production Systems

Cellular manufacturing is a technique, which eliminates waste by matching the appropriate production equipment and sequencing in order to produce a selected product family. It is a technique that is often imitated, but seldom implemented correctly. To avoid the pitfalls of poor implementation one must first understand the philosophy behind the practice. Designing a manufacturing cell is more complicated than simply arranging equipment into a U-shape. The selection and sequencing of the equipment must be arranged so that the cell layout encourages the lean principles of communication, single-piece-flow, flexibility, waste reduction, and elimination of unnecessary transport. Although the U-shape is often advocated the shape of the cell is not as important as the principles behind the layout.

2.2.6 KANBAN PUSH/PULL SYSTEM

The concept of pull in lean production means to respond to the pull, or demand, of the customer. Lean manufacturers design their operations to respond to the ever-changing requirements of customers. Those able to produce to the pull of customers do not need to manufacture goods that traditional batch-and-queue manufacturers must rely on. The planning for delivery of product to customers is less troublesome, and demand becomes more stable if customers have confidence in knowing that they can get what they want when they want it.

Kanban is a Japanese word that means "instruction card". Kanbans are manual pull devices that allow an efficient means to transfer parts from one department to another and automatically reorder products using minimum/maximum inventory levels. A Kanban is a signal, such as an empty container returned to the start of the assembly line that signals the need for replenishment of materials to a user.

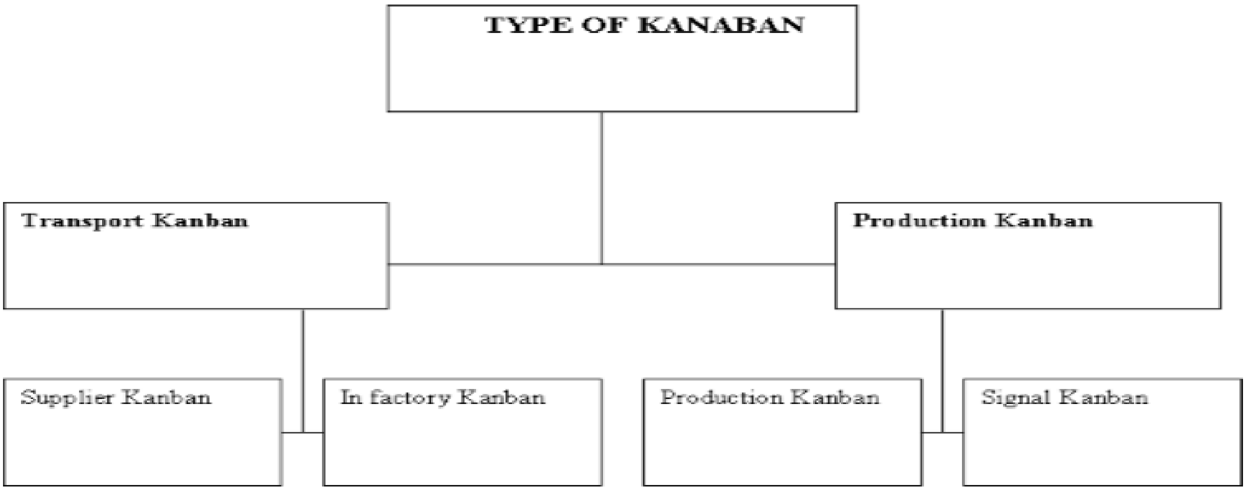


Figure 2.2.6 Type of Kanban

2.2.7 Six-Sigma

Six-Sigma is a rigorous, disciplined, data-driven methodology that was developed to enhance product quality and company profitability by improving manufacturing and business processes. Six-Sigma uses statistical analysis to quantitatively measure how a process is performing. That process can involve manufacturing, business practices, products, or service.

To be defined as Six Sigma means that the process does not produce more than 3.4 defects per million opportunities (DPMO) – which translates to 99.9997% efficiency.

2.2.7.1 Six-Sigma Implementation

To achieve Six Sigma performance, the causes of manufacturing and business process defects and variation must be identified and eliminated. Two Six Sigma sub-methodologies were developed for this purpose:

1. DMAIC (Define, Measure, Analyze, Improve, Control) and
2. DMADV (Define, Measure, Analyze, Design, Verify).

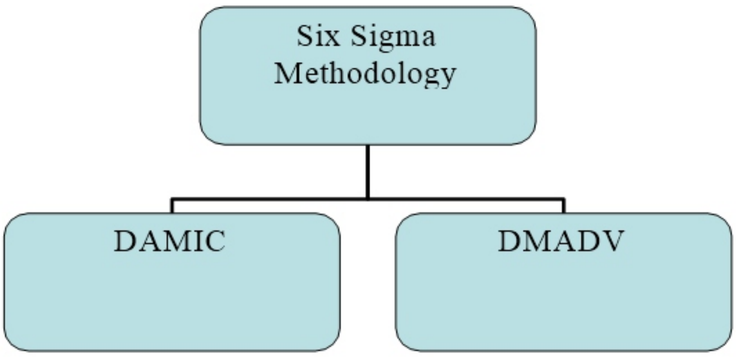


Figure 2.2.7.2 Six Sigma Methodology

2.2.8 Pre-Production Planning

Pre-production is the process of planning the recording. It's our chance to make sure that no time and money is wasted, either by us or by the people paying for it all.

Pre-production takes the form of meeting to discuss the project. The following outline is a workable way to cover all the bases. If possible, hold the pre-production meetings in the studio. This gives the artist a chance to get used to the environment, helping them to be less nervous when recording starts.

Whereas other lean method s take a product and its core production process steps and techniques as given, the pre production planning (3P) Focuses on eliminating waste through ‘’Greenfield’’ product and process redesign.3p represents a key pivot point, as organizations move beyond a focus on efficiency to incorporate effectiveness in meeting customer needs. Lean experts typically view 3P as one of the most powerful and transformative advanced manufacturing tools, and it is typically only used by organizations that have experience implementing other lean methods. 3P seeks to meet customer requirements by starting with a clean product development slate to rapidly create and test potential product and process design that require the least time, material, and capital resource.

3. SIX SIGMA

Six-Sigma is a rigorous, disciplined, data-driven methodology that was developed to enhance product quality and company profitability by improving manufacturing and business processes. Six-Sigma uses statistical analysis to quantitatively measure how a process is performing. That process can involve manufacturing, business practices, products, or service. To be defined as Six Sigma means that the process does not produce more than 3.4 defects per million opportunities (DPMO) – which translates to 99.9997% efficiency.

3.1 Six Sigma Calculations

The term “Six Sigma” comes from process capability studies, which measure the extent to which a process meets customer requirements, specifications, or product tolerances. Sigma represents the standard deviation (variation) from the process mean of a statistical population. There are two common measures of process capability: Cp and Cpk. These measures compare the variation within the output of a process with the specification limits for the product being produced or in other words they simply measure a process’s capability to produce what was designed. Cp is a ratio, which equals six standard deviations of the measured output divided by the tolerance range. [30]

The process capability index is computed using the following formula,
Where
Cp = process capability,
USL = upper specification limit,
LSL = lower specification limit, and
σ = sigma:

$$C_p = \frac{USL-LSL}{6\sigma}$$

Where σ = (R bar/d2)

As the equation indicates, higher Cp values are found in more capable processes. As the process standard deviation goes up, or the mean of the process moves away from the center of the tolerance, fewer standard deviations will fit between the mean and the nearest specification limit, thereby decreasing the sigma number and increasing the likelihood of items outside specification. Numerous process sigma calculators are available on the Internet that provides quick calculation of how a particular process is performing with regard to the Six Sigma goal. The calculation of a sigma level is based on the number of defects per million opportunities (DPMO). [24]

The formula to calculate DPMO is:

$$\text{DPMO} = \frac{(\text{Number of defect} \times 1{,}000{,}000)}{((\text{Number of opportunities/unit}) \times \text{Number of units})}$$

3.1 USING SIX SIGMA IN GEAR COMPANY

Problem- To eliminate the problem of rejection and rework due to teeth span size variation of Transmutation Gears (GG 1491/1) after shaving.

Blank OD SizeProcess Flow Chart-

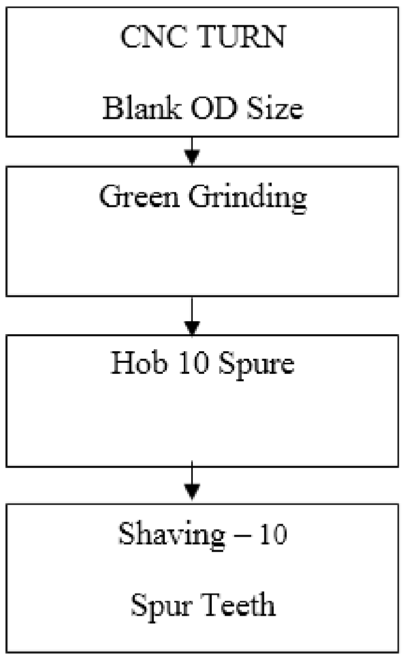


Figure 4.3.1 Flow Process Chart

Solution by DAMIC methodology

Phase -1: Define the problem

1) Problem Statement: Teeth Span Size Variation.
2) Response to be measured: Teeth Span Size (For Component to Component) and Teeth Span Outness.
3) Instrument used to verify the Response: Teeth Span Micrometer.

Phase -2: Measure and analysis (Data collection planning & execution)

Before Improve phase Re-check the all statistical process controls. Sample of 9 pieces was taken each day for 6 days. The value of six sigma- 3.3 (by company)

Phase -3:

After Improve phase Re-check the all statistical process controls. Sample of 9 pieces was taken each day for 6 days. The Variation is as given below. All data in mm.

Control Charts for Variables: Teeth Span Size Variation

S.NO.	DAY1	DAY2	DAY3	DAY4	DAY5	DAY6
1	17.7	17.87	17.58	17.66	17.83	17.33
2	17.69	17.56	17.56	17.56	17.79	17.58
3	17.68	17.79	17.87	17.91	17.19	17.86
4	17.67	17.78	17.45	17.83	17.89	17.74
5	17.69	17.93	17.93	17.92	17.76	17.34
6	17.65	17.82	17.53	17.59	17.67	17.54
7	17.09	17.81	17.78	17.71	17.95	17.61
8	17.69	17.82	17.83	17.89	17.95	18.31
9	17.7	17.44	17.65	17.57	17.81	17.54
X(bar)	17.6178	17.7578	17.6867	17.7378	17.76	17.65
R(bar)	0.61	0.49	0.48	0.36	0.76	0.98

Table - Teeth Span Size Variation

Note: In Microsoft word I use special notation are X (bar), X (Double bar), Sigma etc. So please consider that.

X (bar) And R Chart:

Now, X (double bar) =åX (bar) / N Where N= 6

X (double bar) = (17.61+17.75+17.68+17.73+17.76+17.65)/6

=17.7018

Range=R (bar) = å R/N

=0.61+0.49+0.48+0.36+0.76+0.98/6

=0.6133

For X (bar) chart:

UCL for X (bar) = X (double bar) +A2R (bar)

=17.70+ (0.34×0.61)

=17.91mm

LCL for X (bar) = X (double bar) - A2R (bar)

= 17.70- (0.34×0.61)

= 17.49 mm (A2=0.34 for subgroup of 9 from table appendix-1)

For R chart

UCL For R = D4R(bar)

= 1.82×0.61 (D4= 1.82 for subgroup of n = 9 from table Appendix-1)

= 1.11

LCL For R= D3R(bar)

= 0.18×0.61 (D3= 0.18for of n = 9 from table Appendix-1)

=0.109

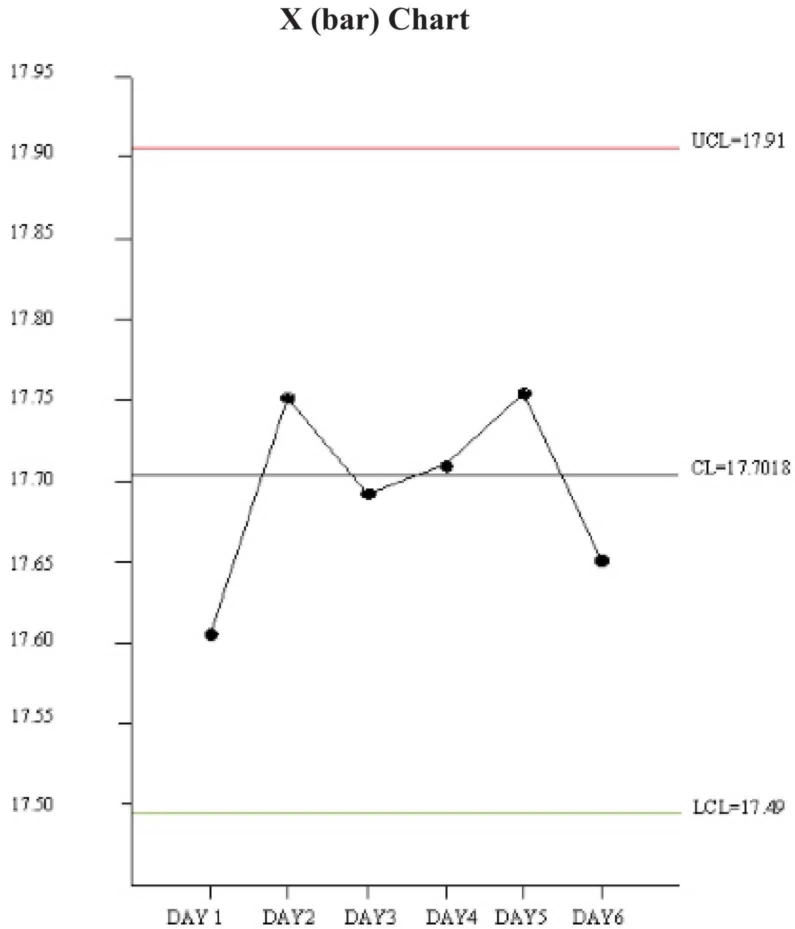


Figure 4.3.6 Graph for X (bar) Chart

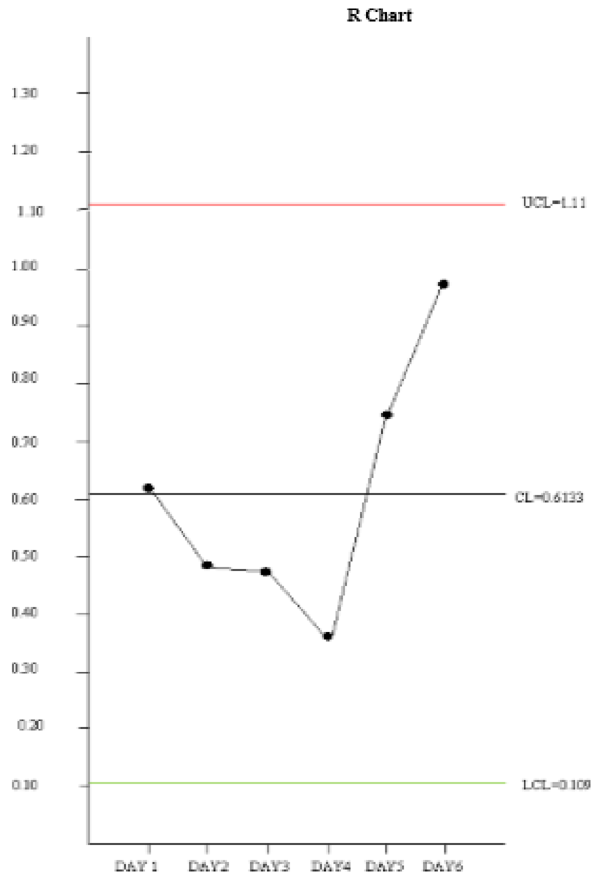
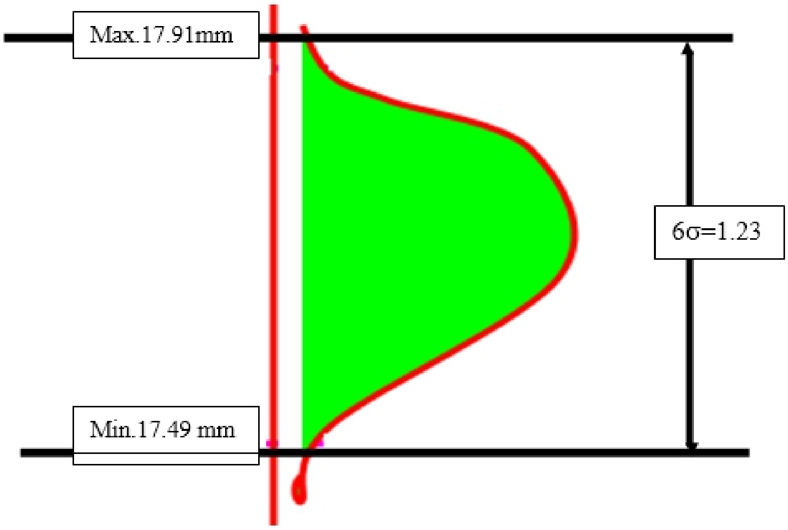


Figure 4.3.7 Graph for R-Chart

s=R (bar)/d2
=0.61/2.97
=0.20538 6s=6×0.20538
=1.23



Area under Curve:
X (double bar) =17.70mm
X max. =17.91 mm
Xmin. =17.49mm
Z1=Xmin. - × (double bar)/ σ
= 17.49-77.70/0.205
=-1.02
A1=0.15386 (A1= 0.15386 for Z1 =-1.02 from Reference 21)
Z2=X max- X (double bar)/ σ
=17.91-17.70/0.205
=1.05
A2=0.853149 (A2=0.853149 for Z2 =1.05 from Reference 21) Area under Curve=A2-A1
=0.853149-0.15386
=0.6992

Process Capability Cp=USL-LSL/6σ
=18.32-17.09/ (6×0.2053) =1
Process Capability index Cpk=Min, {X (double bar)-LSL/3σ }, {USL-X (double bar)/3σ}
= Min.{17.70-17.09/3×0.2053}, {18.89-17.77/3×0.2053}
= Min.{0.61/0.61}, {0.62/1.061}
=Min. {1.00}, {1.016}
=1 { The process is capable (Cpk>, = 1)} Calculating a Sigma Level
Defect=15 Opportunity per unit=4
Defect per unit (DPU) =400/15
=0.275
Defect per unit opportunity (DPO) =15/400×4
=0.009375
Defect per million opportunity (DPMO) =DPOX1000000
=0.009375×1000000
= 937

Sigma Value = 4 (Sigma= 4 form Appendix-2)

4. RESULTS:

S.No.	Parameter	Before	After
1	Cpk	0.612	1
2	Process Stability	No	Yes
3	DPMO	41250	9375
4	Sigma Level	3.3	4
5	Area Under Curve	0.68	0.6992
6	Cost Saving	………	2.8 Lac.

5 CONCLUSIONS

The results of the case study indicate that the sigma level substantially improved from 3.3 to 4. From Six Sigma it has been found that the results are consistent - better customer satisfaction .In other words, create more value for customers at much lower cost to eliminate the problem of rejection and rework due to teeth span size variation of Transmutation Gears after shaving.

Six- Sigma is applied for quality improvement of the product. There are many other potential areas where Six- Sigma can be effectively applied such as problem of rejection and rework due to bore size variation in finish grinding operation, problem in face out ness, problem of rejection & rework due to size variation and outer diameter out ness in hard turning operation on turning centre.

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Faults Diagnosis and their Remedies in the Manufacturing of Heat Exchangers: A Case Study

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ABSTRACT

We devoted our attention towards improved engineering techniques in the field of manufacturing and inspection of shell and tube type heat exchangers after collecting design data from B.P.C.L. (Bharat Pumps and Compressors Ltd), Naini, Allahabad (U. P.), India. In this paper remedial steps /procedures/improved techniques have been proposed for all the manufacturing /assembly/heat treatment operations. The main objective of this paper is to prepare a useful guide to the manufacturers and quality control people.

Keywords: Heat exchanger; Tube bundle assembly, baffle plate.

1. INTRODUCTION

The author visited BPCL industry at Allahabad and tried to know the faults / operations taking more time in the manufacturing of the shell and tube type heat exchangers. The author suggested the diagnosis of the time taking/ poor operations with the help of the reference [1-10].The major problems faced by manufacturers were found in the following operations.(i) Drilling of tube sheets,(ii) Drilling of baffle plates, (iii) Tube bundle assembly, (iv) Tube expansion,(v) Tube to tube sheet joints,(vi) Exchanger shell assembly, (vii) Exchanger assembly, (viii) Heat treatment (ix) Testing,(x) Shipment,(xi) Removal and plugging of holes during servicing. Etc.

2. SUGGESTED DIAGNOSIS AND REMEDIAL STEPS

The remedial steps are prepared with the help of several references including [1-11] and several meetings with engineers, foreman, supervisor and skilled worker of the plants. I feel that they people know the problems and to a large extent solution also. But time factor is a crucial one for them. Everyone is busy to achieve one's target. The suggested remedial steps for various operations are as follows.

2.1 Drilling of Tube-Sheet

(i) A thin aluminum sheet template Printed with the required tube layout with hole centers accurately marked should be used.
(ii)Punch marks should be marked with red pen to avoid drilling of unwanted holes.
(iii) Similarly the tie rod holes should be marked with paint to indicate the operator that these types of holes and eye bolt holes are not to be drilled through full thickness of the tube sheet.
(iv) Table-1 and Table- 2 would serve as a guide line for manufacturer.

Table-1: Speeds and feeds for drilling

HOLE SIZE mm	PIOLET DRILLING			PREDRILLING			FINAL DRILLING		
	DIA mm	R.P.M mm/rev	FEED mm/rev	DIA mm	R.P.M mm/rev	FEED mm/rev	DIA. mm	R.P.M mm/rev	FEED mm/rev
10.15	6.0	450/600	0.12	8.0	300/400	0.3	9.75	350/450	0.5
16.20	6.0	450/600	0.12	14.0	300/400	0.3	15.75	350/450	0.5
20.20	6.0	450/600	0.12	18.0	250/350	0.3	19.75	300/350	0.5
25.25	6.6.	450/600	0.12	23.0	200/300	0.3	24.75	250/300	0.5
38.35	6.0	450/600	0.12	25.0	200/300	0.3	37.50	80/600	0.5

Table-2: Speeds and feeds for reaming

HOLE SIZE mm	REAMER DIA mm	FAST HELIX REAMER		SOLID REAMER	
		RPM	FEED mm/rev	RPM	FEED mm/rev
10.15	10.15	200/300	0.2-0.30	80/100	0.2
16.20	16.20	200/300	0.2-0.30	80/100	0.2
20.20	20.20	200/300	0.2-0.30	60/80	0.2
25.25	25.25	200/300	0.2-0.30	60/80	0.2
38.25	38.25	80/100	0.2-0.30	40/60	0.2

2.2 Drilling of Baffle Plates

Assemble all the baffles in the same sequence as they would be fitted inside the exchanger. Baffle should be welded at its periphery at few places to act as a single unit. Punch serial number (S.No) on outside diameter of each and every baffle such as S. No. I, 3, 5 … for bunch 'A' and 2, 4, 6. … for bunch 'B' and arrange the baffles as they would be in actual exchanger. Pass the exchanger to through baffle holes. Mark the segment to be cut from full diameter baffle (except supported baffle) to get the desired shape of the segmental baffle as per drawing.

2.2.1 U- Tube Bundle Assembly

Follow U- tube assembly break down diagram as shown in Fig.1. Components required for tube bundle assembly are shown in Table-3.

2.3 Tube Expansion

It is suggested that the expansion of tubes should be done hydraulically in place of mechanically as it is the latest technique for expanding tube. In this technique, tube sheet employs hydraulic pressure instead of rollers. Sufficient hydraulic pressure is applied to improve tensile stresses in the tube wall about 115% of the yield stress and thus expand the tube firmly into the tube sheet. This technique has the advantage that it is applicable to any thickness of tube sheet, can be controlled accurately and tube thickness are accommodated. Pressure as high as 483 MPa are employed for thick walled tubes.

2.4 Tube to Tube Sheet Joints

The criteria for selection of joints are given in the Table-4 and Table-5. In the present study the material of shell and tube type heat exchanger is carbon steel. So rolling in plain holes and strength welded joints are recommended. There should be no grooved holes in the tube sheet because retubing in grooved holes is not possible as the holes invariably become oversized when leaking tubes are removed.

2.5 Exchanger Shell Assembly

Follow the suggested shell assembly break down diagrams shown in Fig.2, Fig.3. and Fig.4. Sub assembly and components required are shown in Table-6 and Table-7 respectively

Table-3: Components for Tube Bundle Assembly

Item no.	Description	Quantity
301	Tube sheet.	01
302	U-Tubes.	as per design
303	Baffle Plates.	as per design
304	Tie rods.	as per design
305	Spacers pipes.	as per design
306	Slidingrod	02
307	Eye bolts	02
308	Jack screw	06 or as required
309	Hex nut	as required
310	Lock nut	as required
311	Stopper plate	03
312	Plug for eye bolt hole	02

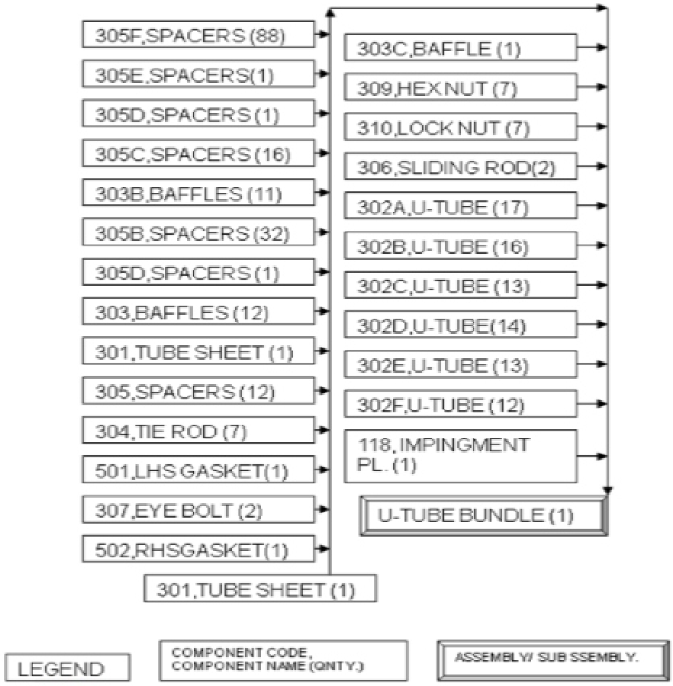

Fig.1: U-TUBE BUNDLE ASSEMBLY BREAK DOWN DIAGRAM

Table-4: Joints for Carbon steel and alloy steel

S. No	Pressure Kg/cm^2	Temp^r °C	Fixing arrangement	Remarks
1	<=6	<=175 , <=350	Roll in plain holes seal welds Roll in grooved holes only	when Intermixing is dangerous
2	<6<= 40	<=350	Roll in grooved holes only.	Intermixing not dangerous
3	>6<=40	<=350	Roll in grooved holes & seal weld	Intermixing angerous
4	<.40<=8 0	<=350	Roll in grooved holes& seal weld	-----
5	<=350	<=350	Roll in plain holes and strength weld	-------
6	All Prs.	<=350	Rolling plain holes& strength weld	------

Table-5: Joints for stainless steel

S. No	Pressur eKg/cm 2	Temper °C	Fixing arrangement	Remark
1	<=6	<=175 <=350	Roll in plain holes and seal welds Roll in grooved holes Seal weld	------ if intermixing dangerous
2	<=6 =80	<=350	Roll in grooved holes and seal weld	--------
3	>80	<=350	Roll in grooved holes and seal weld	-----
4	All Prs.	<=350	Roll in grooved holes and seal weld	------

Table-6: Components required for shell assembly

NOZZLE	DESCRIPTION	QNY
N1	SHELL INLET	01
N2	SHELL OUTLET	01
N3	CHANNEL INLET	01
N4	CHANNEL OUTLET	01
V1	VENT (SHELL)	01
V1	VENT(CHANNEL)	01
D	DRAIN (SHELL)	01
C1	PRESSURE.CON.	04
C2	THERMO.CON.	04

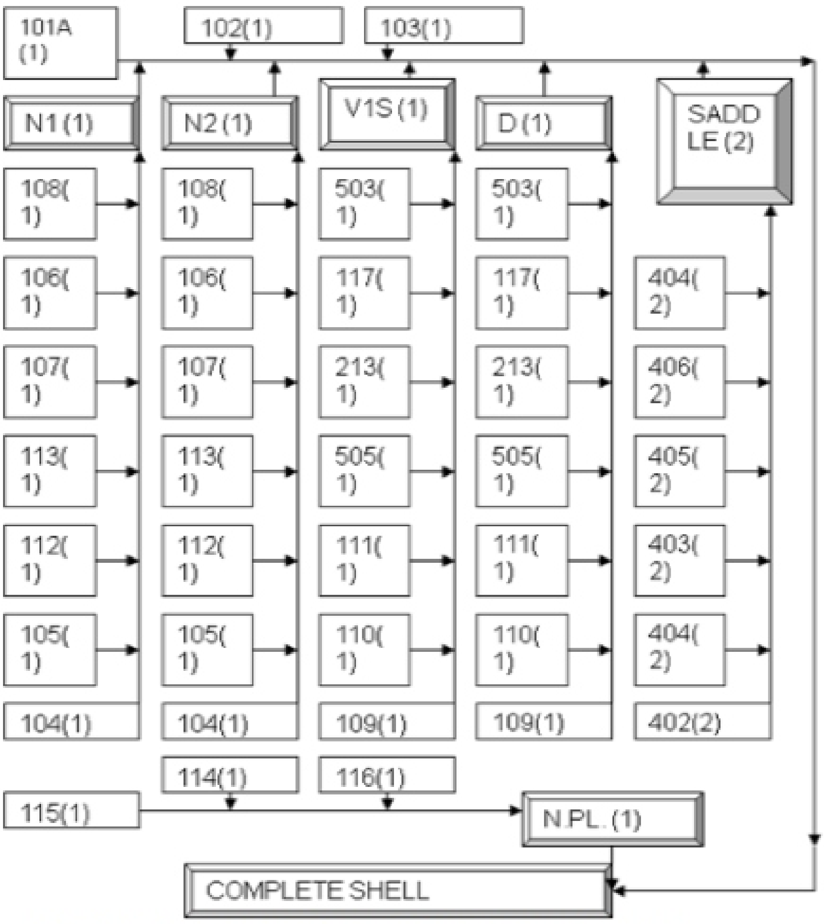

Fig.2: Exchanger Shell Assembly Breakdown Diagram

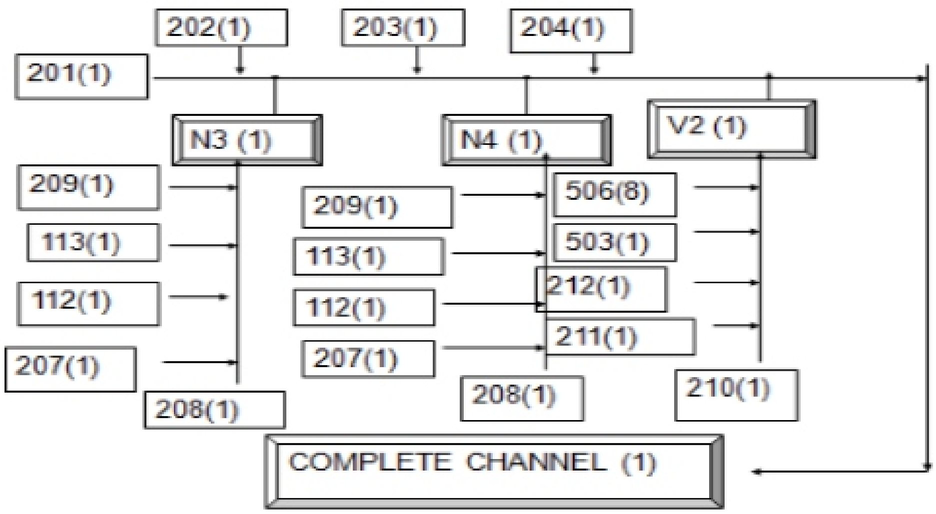

Fig.3: Channel Assembly Break down Diagram

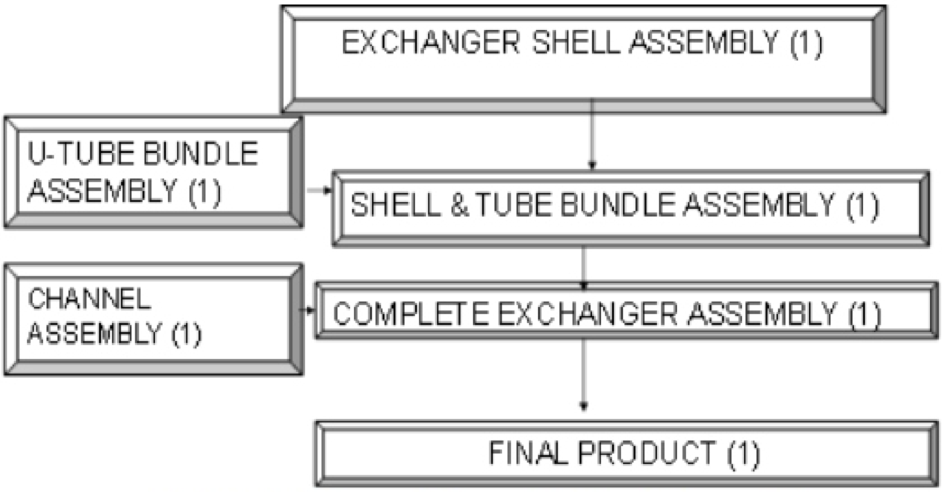

Fig.4: Exchanger Assembly Break down Diagram

2.6 Heat Treatment

Weld the tube with tube sheet. Stress relieves the exchanger by leaving the tubes free in the baffles and the tie rods. The circulation of nitrogen is recommended to protect the tubes and tube sheet holes from oxidation during heating. The valves besides air discharge and nitrogen, feed serve to regulate the pressure inside within acceptable values during heating and cooling. All air should be driven out from exchanger before heating the shell. The rate of heating and cooling should be maximum 50˚C/hour

2.7 Testing of Joints

Pneumatic test should be adopted after hydraulic test.

2.8 Removal of Defective Tubes

Relieve the tube to tube sheet weld with taper end mill. Mill the hole down to 5 mm from the tube sheet face. Drill the tube with spiral fluted end mill up to expanded length of the tube. Use lubricating oil freely. Knock out tube from the tube sheet. Expanded portion will automatically collapse. Now, tube sheet holes should be examined carefully of surface condition and cleanliness of grooves and necessary steps should be followed.

2.9 Shipment

Internal and external surface should be free from loose scale and other foreign materials. All external carbon steel surfaces should be painted with red lead primer. Water, oil or other liquids used for cleaning shall be drained before shipment. All exposed machined contact surfaces should be coated with a removable rust preventive and protect against mechanical damage by suitable covers. All threaded connections shall be suitably plugged. The exchanger and any spare parts should be suitably protected to prevent damage during shipment.

2.10 Plugging of Holes

In many cases, it is impossible to replace tubes after failure has occurred, when leakage between a tube wall and tube sheet has developed to such an extent that the tube sheet material has been badly eroded than the tube hole must be permanently plugged by welding.

2.11 Plugging the Tube Holes by Removing the Tubes

(i) Remove tube as described earlier. (ii)Machine the plug. Material of the plug should be same as that of the tube sheet. (iii)Clean the holes free from all dirt and pitting and push fit the plug with light hammering. (iv)Complete the welding of the plugs to tube sheets,

2.12 Plugging the Hole with Tubes in Position

Mill cut the tubes to tube sheet welding using taper end mill. Push fit the plugs after cleaning I.D. of the tubes of all dirt etc. Complete welding of the plugs to the tube sheet. After completing welds, apply hydraulic test on shell side using full permissible test pressure. Keep test on shell side using full permissible test pressure. Keep test pressure for few hours to check the soundness of welds.

3. RESULTS AND DISCUSSION

The data regarding faults were collected for a period of 8 months from the rejection and rectification register, the components returned back by the customers for repair and maintenance purpose and on the basis of customer's complaints. The special causes of the faults have been observed. It is sometimes difficult to determine the source of the special cause variability, but elimination of these problems is necessary to obtain a stable manufacturing process. The speeds and feeds for drilling and reaming suggested from the references are shown in Table-1 and Table-2. The components for tube bundle assembly are shown in Table-3. Table-6 and Table-7 show the sub-assembly and components of a shell respectively. The proposed assembly break down diagrams is presented by Fig.1, Fig2, Fig3 and Fig.4 respectively. The guide lines for selection of joints are shown in Table-4 and Table-5 respectively.

Table -7: COMPONENTS SHELL ASSEMBLY

ITEM NO	DESCRIPTION	QTY
101A	PLATE FOR SHELL	3
102	PLATE FOR SHELL'D' END	1
103	GIRTH FLANGE FOR SHELL	1
104	W.N.FLANGE FOR N1&N2	2
105	NOZZLE FOR N1&N2	2
106	NOZZLE FOR N1&N2	2
107	BEND FOR N1&N2	2
108	R.F.PADFOR N1&N2	2
109	NOZZLE FOR N1&D	2

110	W.N.FLANGE FOR V1&D	2
111	BLID FLANGE FOR V1&D	2
112	COUPLING FOR C1&C2	4
113	PLUG FOR C1&C2	4
114	NAME PLATE BRACKET	1
115	NAME PLATE	1
116	SCREWS	4
117	STIFFNERS	1
118	IMPINGMENT PLATE	1
201	PLATE FOR CHANNEL	1
202	PL.FOR CHANNEL 'D'END	1
203	GIRTH FLANGE CHANNEL	1
204	PASS PARTITION PLATE	1
207	NOZZLE FOR N37N4	2
208	W.N.FLANGE FOR N3&N4	2
209	R.F.PAD FOR N3&N4	2
210	NOZZLE FOR V2	1
211	W.N.FLANGE FOR V2	1
212	BLIND FLANGE FOR V2	1
213	STIFFNERS	2
401	WRAPER PLATE	2
402	BASE PLATE	2
403	STIFFNER FOR SADDLE	2
404	ROB FOR SADDLE	4
405	RIB FOR SADDLE	2
101B	PLATE FOR SHELL	5
501	L.H.SIDE GASKET	5
502	R.H.SIDE GASKET	5
503	GASKET FOR V1,V2&D	15
504	STUD & 2 NUT FOR G.FLG.	32
505	STUD & 2 NUT FOR V1&D	12
506	STUD WITH 2 NUT FOR V2	8

4. CONCLUSIONS

From the above case study, it can be clearly noted that there is a tremendous difference between the traditional methods and implementation of the proposed improved techniques. By applying the proposed techniques in the manufacturing of the shell and tube type heat exchanger, the 20 % overall improvement may be there. This study may be used as a guide by the manufacturers as well as quality control personnel of heat exchangers.

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Diesel Engine Performance Analysis with Blend Fuel of Biodiesel and Turpentine Oil as Biofuel Additive

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ABSTRACT

Experiments were conducted on diesel engine to study and measure the suitability of biodiesel (BD) and Turpentine (T) blend as a replacement for diesel fuel. The result shows that the performance of engine with various blends was found to be near to diesel. Emissions were improved and combustion characteristics were found to be comparable with diesel fuel. The maximum brake thermal efficiency obtained with BD70T30 blend fuel, which is 3.72% lower than that of diesel at full load, but the BSFC increases for blend fuels at part load and also same at full load. Carbon monoxide, Hydrocarbons and Smoke emissions were reduced by 75%, 65% and 62.3% respectively compared to diesel at full load, whereas nitric oxides were increased by 9.08% for BD70T30 blend fuel. Turpentine additive in Biodiesel offer decrease in viscosity and flash point that leads to complete combustion which increases power output. The performance and combustion features with reduced emissions are comparable to diesel and the blend fuel is capable of replacing C I engines diesel fuel.

Keywords: Performance, Turpentine oil, Emissions, POME, Biodiesel, Properties, Additive, Blend fuel.

1. INTRODUCTION

Vegetable oils use in diesel engine has been identified as promising alternative fuel to diesel. Lack of technical feasibility and high cost of vegetable oils could not get acceptance as fuel. Vegetable oils are highly viscous, which can be reduced by converting into biodiesel to use as fuel in diesel engine. Turpentine oil is one such biofuel that can be used in diesel engine as an additive. Diesel fuel blended with 30% of Turpentine oil fueled (TPOF) in a diesel engine, produced higher brake power and net heat release rate with a net reduction in exhaust emissions such as CO, HC, NOx, smoke and particulate matter. Above 30% TPOF blends, developed lower brake power and net heat release rate because of lower calorific value but still emissions were reduced [1]. Specific fuel consumption decreases with 5% turpentine oil blend fuel, due faster evaporation and combustion of the blend particles as compared with pure diesel fuel [2]. The clove and turpentine oils used as a bio-additive fuel with diesel and concluded that decrease in fuel consumption, flow rate CO, HC and smoke emissions, this is due to containing more oxygen and the bulky structure of compounds inside the bio-additive [3]. The heat release rate for bio-additives reduces as compared with diesel [4]. Biobased fuel additives become more important when environmental concerns is considered. By using Pine oil as biofuel, the BSFC was 16.2% lower for 36% pine oil injection than 6% pine oil injection at 100% load and peak heat release rate is maximum, cylinder pressure increased with the increase of pine oil injection at 100% load [5, 6].

The BSFC and BTE were improved with the increase in proportion of pine oil injection. Further, combustion of fumigated pine oil has been reported to be better, with 36% injection of pine oil shows 10.3% higher in- cylinder pressure than that for 6% injection of pine oil at 100% load on engine [7].

Introduction of Turpentine oil as a primary fuel through induction manifold and diesel through conventional fueling device, the performance and emission parameters are better than those of diesel fuel within 75% load. The toxic gases like CO, UBHC are slightly higher, where as smoke reduction is obtained with dual fuel mode. The pollutant NOx is found to be equal to that of diesel fuel operation except at full load [8]. Jatropha biodiesel- Wood Turpentine blends offered comparable performance and combustion features, reduced emissions and it is capable of replacing standard diesel in compression ignition engines. [9]. COME biodiesel with 10% Triacetin additive proved encouraging results in all respects of performance and emissions of the engine. Methyl and ethyl esters of Pongamia and Mahua oils at BD20 blend with diesel, of all results Pongamia oil methyl ester produces more power, but 13.2% less than diesel fuel at 3.22% more specific fuel consumption at maximum load [10,11]. In this paper palm oil is used to make biodiesel by transesterification process called palm oil Methyl Ester (POME). Experiments were conducted with Biodiesel and Turpentine oil at different percentages as blend fuel and the obtained results were compared with diesel fuel.

2. MATERIALL AND METHODS

2.1 Making of palm oil Methyl Ester

Biodiesel is prepared from the Palm oil by using transesterification process. Filtered pure oil is acid treated with methanol and sulfuric acid to remove some of the fats as glycerin. In the base treatment methanol and NaOH (Sodium Hydroxide) are thoroughly mixed to form a clear solution called "Sodium Methoxide". This solution is added to the acid treated oil and stirred along with heating at 600C to neutralize sulfuric acid. When the solution turns into brown silky in colour, that shows the whole reaction is completed (Fig. 1). After settlement of mixture the bottom part of the glycerin is separated from the biodiesel. The obtained palm oil methyl ester (POME) is bubble washed with distilled water to remove soaps. Washing is repeated till the POME separated with clear water. Prepared POME is heated to remove water and formed biodiesel is tested for properties [12].

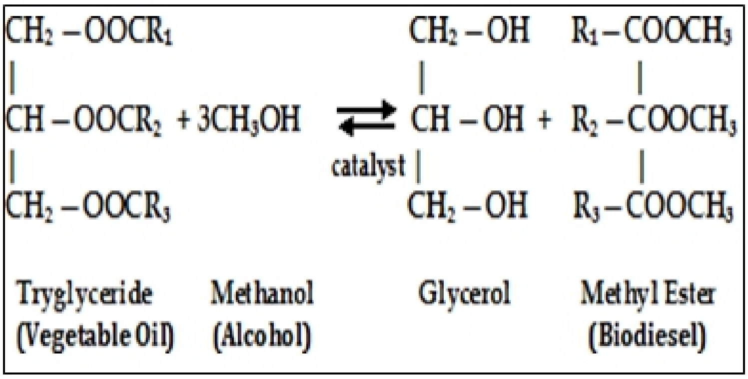


Fig. 1 Chemical reaction of Biodiesel formation

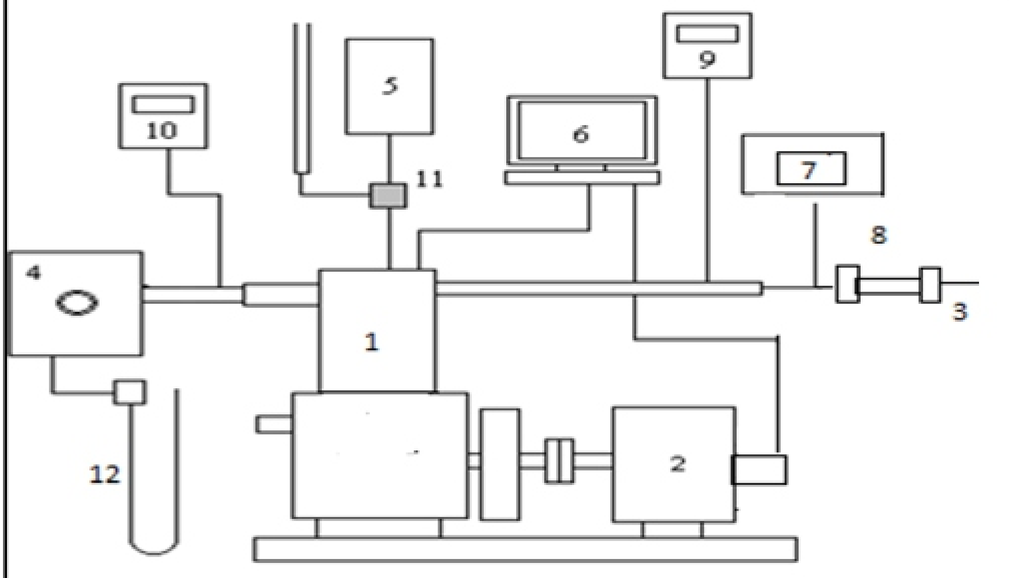
Fig. 2 Biodiesel (POME)

2.2 Turpentine oil

Mostly Turpentine oil is used in domestic and industrial applications. The studies on diesel engines with turpentine oil and biodiesel as blends gives better performance and lower emissions. Turpentine oil can be easily extracted from pine trees and can be used as a biofuel additive. Physically, it is a yellowish, opaque, colour less and water-immiscible liquid. Chemically, the turpentine oil is flammable, volatile, combustible and it contains α–pinene 40% by weight in turpentine. This oil consists of 58–65% γ – pinene along with β– pinene and some other isometric terpenes. The properties such as viscosity, calorific value, and cetane number, are comparable to diesel, hence it can be used with biodiesel in any proportion to reduce the dependency on conventional fossil fuels. The emissions are at lower level with turpentine oil as compared to traditional diesel fuel. With minor changes in the engine design 60-65% of diesel fuel can be replaced with turpentine in dual fuel operation mode [13]. The performance of engine with turpentine oil such as specific fuel consumption, brake thermal efficiency, exhaust gas temperature and emission characteristics are found better as compared to diesel fuel [14]. The Turpentine oil used for experimental work is obtained from available paints shop in Warangal.

3. EXPERIMENTATION

Experiments were conducted on C I engine for diesel, biodiesel with Turpentine oil at 10, 20, 30 and 40 percentages by volume to full load range of the engine. The experimental setup details are shown in Fig. 1 with engine specifications in Table 1. The blend fuels were prepared with biodiesel and Turpentine oil as a bio-additive. The blends tested were BD90T10, BD80T20, BD70T30 and DB60T40 (60% biodiesel mixed with 40% of Turpentine oil) as shown in Table 2. For the best performance results, stirring method is used to ensure uniform mixing of Turpentine oil with biodiesel. A water cooled eddy current dynamometer is coupled to the engine for loading precisely. During the engine test, performance and emission parameters were measured. Exhaust temperatures and fuel consumption were also measured to calculate the performance of the engine. Exhaust gas analyzer was used to measure CO2, CO, HC, NOx emissions and compared the results with diesel fuel.



1. Engine 2. Dynaomometer 3Exhaust gas 4. Air Box 5. Fuel tank 6. Computer 7. Exhaust analyzer 8. Smoke meter 9. Exhaust Temp. 10. Air temp. 11. Fuel measurement 12. Air Measurement

Fig. 3 Experimental setup details

Table 1. Engine details

Manufturer	Kirloskar Make
Engine	4stroke, Water cooled
Dynamometer	Eddy current type
Rated power	3.68kW@1500 rpm
Cylinder Bore	80mm
Stroke length	100mm
C R	16:01

Table 2. Fuels used for Testing

Fuel	Percentage
Diesel	---
Biodiesel(BD)	---
Turpentine	---
BD90T10	90%BD+10%Turpentine oil
BD80T20	80%BD+20%Turpentine oil
BD70T30	70%BD+30% Turpentine oil
BD60T40	60%BD+40% Turpentine oil

4. RESULTS AND DISCUSSION

4.1 Blend Fuel Properties

Test fuels: The prepared blend fuels were tested for their properties. Stirring process was used to ensure uniform mixing of biodiesel with additive in the process of making blend fuels. Standard test procedure was adapted to measure viscosity, flash point and calorific value. The viscosity and flash point values of blend fuels are gradually decreasing (Fig. 4, 5) and the calorific value increase as the percentage of Turpentine oil increases in the mixture as shown in Fig 6. Blend fuel viscosity decreases by 5, 8.1, 10.7, 14%; flash point decreases by 9.5, 17.7, 24.7, 34.2% and calorific value increases by 0.58, 1.1, 1.38 and 1.88% with the addition of 10, 20, 30 and 40% of Turpentine oil in biodiesel as compared to biodiesel properties respectively [15, 16]. Low viscosity makes combustion process easy for biodiesel to release total energy content with no unburned carbon, carbon monoxide and hydrocarbon emissions. Similarly low flash point makes fuel to catch fire instantaneously with no ignition delay and increase in calorific value is useful in giving more power output.

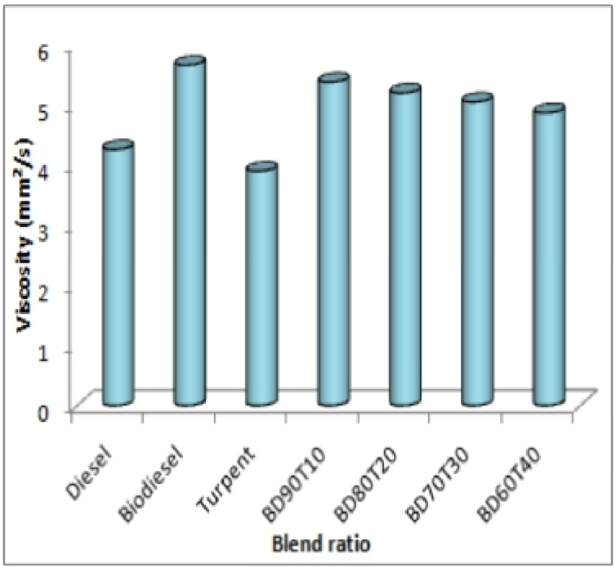


Fig.4 Viscosity variation of biodiesel blend fuels

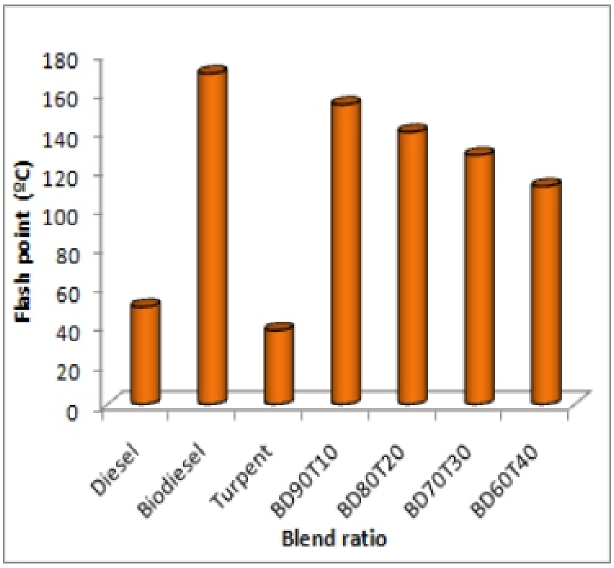
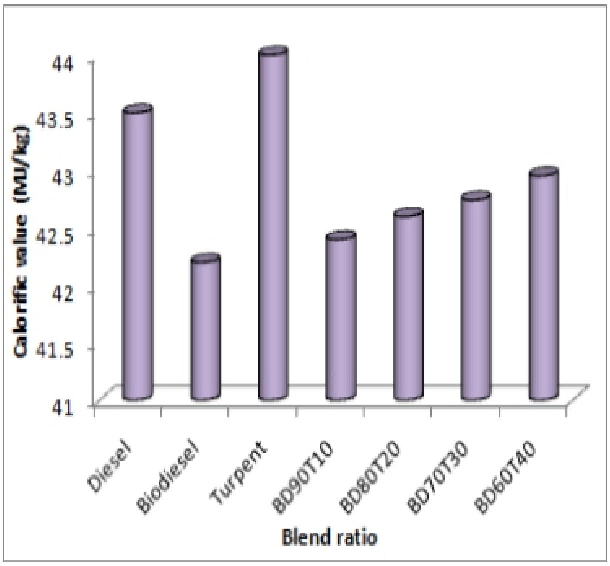


Fig.5 Flash point variation of biodiesel blend fuels

4.2. Performance Parameters

4.2.1. Brake specific fuel consumption (BSFC): By running the engine with BDT blend fuels instead of diesel fuel, the BSFC increases with the percentage of Turpentine oil increase in biodiesel for the entire load range as shown in Fig. 7. The BSFC of BD70T30 is similar and very near to that of diesel fuel. Palm oil methyl ester has lower calorific value and as the content of POME increases in the blend fuel, the heating value reduces that leads to an increased BSFC for the same output. Further high density and viscosity leads to poor atomization and combustion, hence increased fuel consumption to deliver same output causes high BSFC.



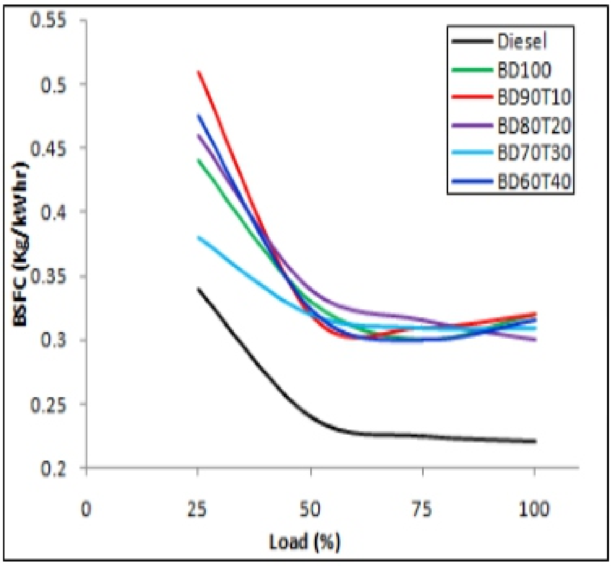


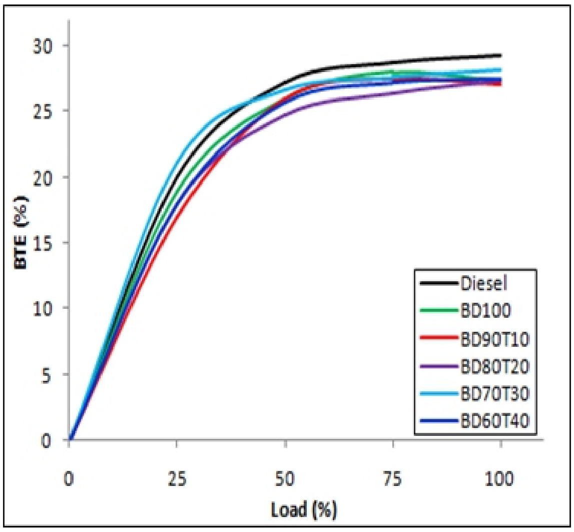
Fig.6 Calorific values variation of biodiesel blend fuels

Fig.7 BSFC variation of biodiesel blend fuels

4.2.1. Brake Thermal efficiency (BTE): The brake thermal efficiency variations with respect to load of neat diesel and blend fuels are shown in Fig. 8. BTE of all blend fuels are lower than that of diesel. However, the thermal efficiency of blend BD70T30 is higher at lower load, but decreased at higher load. This is because of 30% Turpentine oil contains lower calorific value in the blend fuel which releases less heat and high viscosity, reduced volatility of biodiesel lead to poor atomization and combustion. At higher loads to produce same amount of power more blend fuel is consumed, hence the BTE decreases as compared to neat diesel. The BTE of 30% Turpentine oil blend biodiesel is lower but very close to diesel fuel at full load.

4.3. Pollutant Emissions

Unburned Hydrocarbons (UHC): The blend fuels of biodiesel and turpentine oil exhibits lower UHC emissions when compared to diesel fuel. At no load the increase in HC emission may be due to the unavailability of sufficient oxygen during the combustion period. At 75% load the UHC emissions for BD100, BD90T10, BD80T20, BD700T30 and BD60T40 are 76.2%, 62.8%, 54.2%, 47.3% and 28.5% lower and similarly at full load the UHC emissions are 62.1%, 71.9%, 69.48%, 64.7% and 46.3% lower as compared to diesel fuel shown in Fig. 9. It is observed that HC emissions decrease with the percentage of turpentine oil increases in the blends. This is due to relatively more oxygen available for the reaction when blend fuels are injected into the cylinder at higher engine load. The blend fuel emits higher HC emissions at full load than diesel fuel due to insufficient time for combustion fuel.



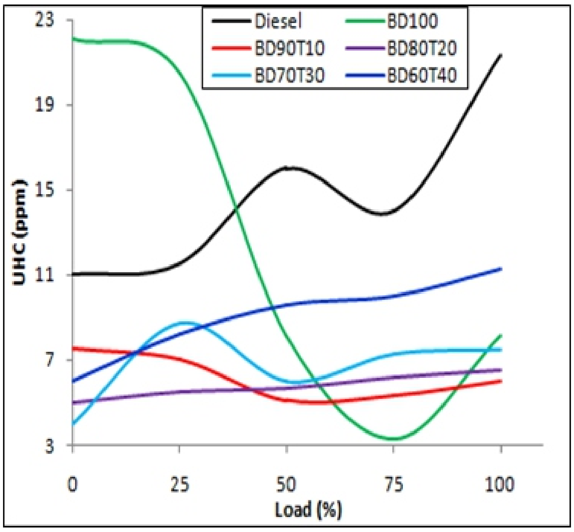


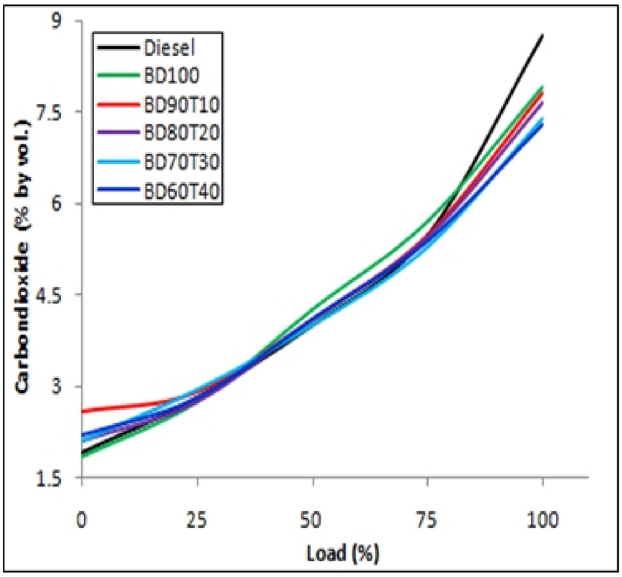
Fig.8 Efficiency variation of biodiesel blend fuels

Fig.9 Hydrocarbon variation of biodiesel blend fuels

4.3.2. Carbon Dioxide (CO2): The variation of CO2 emission values with reference load are shown in Fig. 10. The CO2 emission value obtained for BD70T30 is lowest and near to diesel when compared to all blend fuels. However, for high percentage of turpentine oil in blend fuel CO2 release rate is increased considerably, since the turpentine oil contains more oxygen that leads complete combustion. At lower loads due to less availability of oxygen and at low temperature engine releases more carbon monoxide with less output.

4.3.3. Nitric oxides (NOx): The variation of NOx emissions from biodiesel and blends of biodiesel with turpentine oil with respect to load are shown in Fig. 11. The emissions increased with load for all the blend fuels of turpentine oil. The emissions formation is depend upon the temperature inside the cylinder and stoichiometric ratio of the blend fuel burning. At full load the NOx emissions for B100, BD90T10, BD80T20, BD70T30 and BD60T40 are 12.7%, 7.81%, 11.06%, 9.06% and 21.66% higher than diesel fuel. The NOx emission reduces with turpentine oil blends due to the reduced combustion temperature in the cylinder at full load. Biodiesel premixing has greater oxygen absorptions at lower loads and therefore creates more Nox.

4.3.4. Carbon Monoxide (CO): The CO emission increases with load as shown in Fig. 12. At higher load, rich air-fuel mixture is burnt, and hence more CO is formed due to the no availability oxygen. The increase in CO emission at no load and part load may be due to less oxygen availability for combustion. At 75% Load, the CO emissions for BD100, BD90T10, BD80T20, BD70T30 and BD60T40 are negligible. At maximum load on the engine, temperature inside the cylinder surface is higher, which leads atomization of the blends fuels to improve combustion. Oxygen content in the plant oil makes it easy to burn at the upper temperature in the cylinder.



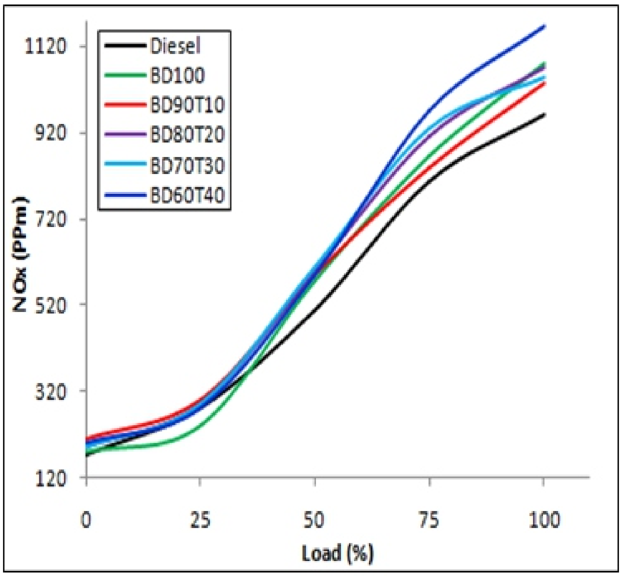


Fig.10 Carbon dioxide variation of biodiesel blend fuels **Fig.11 NOx variation of biodiesel blend fuels**

5. CONCLUSIONS

The following conclusions are drawn from the experiments conducted on engine with Palm oil methyl ester (biodiesel) and Turpentine oil blends as fuel compared to diesel.

- Turpentine additive in Biodiesel offer decrease in viscosity and flash point leads to complete combustion and higher calorific value increases the power output.
- BTE of BD60T40 blend is similar to diesel at 75% and full load condition. The EGT of biodiesel and blend fuels were similar to diesel at all the loads and EGT increases with increase in load.
- The HC emissions of blend fuels were lower at 75% and full load due to more oxygen availability, whereas CO2 and NOx increase with load.

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Analysis of Structural and Magnetic Properties of Cobalt Ferrite Nanoparticles Prepared by Citrate Precursor Method Doped with 1% Cu, Ni And Zn

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ABSTRACT

In the present study, cobalt ferrite has been doped with Ni, Zn and Cu in order to improve the electrical and magnetic properties maintaining a spinel structure and moderate saturation magnetization [1]. Samples of pure cobalt ferrite and cobalt ferrite doped with 1% Ni, Cu and Zn were prepared with citrate precursor route. The samples were annealed at high temperatures 4500C and 6500C to avoid any chances of possible superparamagnetism. These samples were analyzed by XRD and VSM. Analysis of purity of phases was also done to find out the possible impurities. The XRD pattern gave the value of lattice parameter which was analyzed to see the effect to ionic size on size of crystallites. With the help of Scherrer's formula, the sizes of nanoparticles were found and effect of temperature was studied. VSM Studies revealed the saturation magnetization, Coercivity and Retentivity of the samples and effect of temperature and dopant ion on these properties were studied. It is expected that present work will make it easier to quickly synthesize cobalt ferrite nanoparticles by a low cost route and analysis of its properties by taking into consideration the nature of dopant atoms, and annealing temperature.

Keywords: Spinel, Annealing, Scherrer's formula, Lattice parameter, Coercivity, Saturation Magnetization.

INTRODUCTION:

Spinel ferrite nanoparticles have been intensively investigated in recent years because of their remarkable electrical and magnetic properties and wide practical applications to information storage system, ferrofluid technology, magneto calorific refrigeration and magnetic diagnostics. Cobalt ferrite, having an inverse spinel structure and the inherent properties of high coercivity, moderate saturation magnetization and high electrical resistivity and high magnetocrystalline anisotropy is a potential candidate for magnetic storage devices and high frequency applications. Nanometer magnetic particles exhibit specific properties such as superparamagnetism [2] and spin glass behavior generally attributed to surface rather than volume disorder [3,4]. A better understanding of magnetism in such particles is crucial not only for basic physics but also because of the technological applications in information storage and medicine.

A lot of synthetic strategies for preparing nanosized cobalt ferrite have been undertaken. Pileni et al. utilized oil-in-water micelle to prepare size controlled Co-ferrite [5]. Zhang et. al. also reported the nanoparticles which were prepared in normal micelle similarly with same method[6]. Among the series of chemical route various other routes like organometallic precursor method, sol gel method, solution combustion method and hydrothermal method are popular [7]. The citrate precursor route is a chemical method [8], which we adopted and it provides low cost, highly controlled synthesis of nanoparticles with high purity.

We observed that the structural and magnetic property of cobalt ferrite depends mainly on properties of dopant atoms rather than slight variations in annealing temperature.

MATERIAL AND METHODS

The preparations were initiated by calculations of adequate amount of chemicals which may lead to desired pure or mixed ferrite. Generally we took nitrates, as their solubility is high in water. Cobalt nitrate Co (NO3)2 and Ferric Nitrate Fe (NO3)3 were taken in stoichiometric ratio and dissolved in distilled water. In case of mixed ferrite adequate amount of nitrates of the metal e.g. Ni (NO3)2, Cu (NO3)2, Zn (NO3)2 etc. were also taken as solution. Another solution of citric acid was also made and all these solutions were mixed and heated with stirring at 680C for two hours, giving a brown jelly. This jelly was placed in an oven for a day at 800C, which converted into a brittle material. This material was annealed at two temperatures 4500C and 6500C. The samples were analyzed with the help of XRD and VSM.

OBSERVATIONS:

These are the observations in a tabular form, shown in Table 1.

An inspection of the table reveals that in all the samples, when the temperature was increased, crystallite size increased except for Ni0.1Co0.99Fe2O4. This trend is in agreement with other works [9, 10, and 11]. During the annealing, the particles grow due to gain in energy, so higher the temperature, bigger the particles.

Another property is the lattice parameter, which depends on the choice of dopant atoms rather than temperature. As shown in Fig 2, At 4500C, the lattice parameter of pure Cobalt ferrite is 2.52 Å, while it was 2.70, 2.52 and 2.70 Å, when Ni, Cu and Zn are doped respectively. The Cobalt ferrite is an inverse spinel, in which cobalt atom and half of the iron atoms are on B sites, while other half of the iron atoms are on A sites. Among all the dopants, only Zinc has the tendency to go to A sites [12]. On addition of Zn, the lattice parameter increases, it means Zn goes to A sites, and replaces Fe atoms, which are smaller than Zn atoms. Ni goes to B sites, with an option of replacing Fe or Co, but as the lattice parameter increases, we can say that it replaces Fe atoms. Likewise Cu atoms, having affinity for B sites seem to replace Fe atoms only but change is not very large. Our data strengthens earlier views and it can be checked later. The change in lattice parameter with temperature is not significant. The figure 2 is representing the variation of lattice parameter.

The magnetic properties of the samples were analyzed by the hysteresis loops shown as Figure 3 and Figure 4.

We can observe that in almost all the samples, the area has decreased with temperature, indicating it is better to use ferrites annealed at high temperature in memory elements. Additionally, at low temperature all samples behaved almost similarly, but at high temperature, Cobalt ferrite saturated earliest.

We observed that almost all the samples have shown increase in saturation magnetization (Figure5) with increasing annealing temperature [10, 13].

When the external magnetic field is applied over the sample, it tries to orient the magnetic dipoles either by domain rotation or by domain wall movement depending normally on the size of particle. At a particular field, maximum number of dipoles orient, the field is called saturation magnetization. The direction of net dipole moment of A sites and B sites are in opposite direction and their resultant decides the net field.

We know that Zn replaces Fe at A site [12]. The presence of Zn, which is non magnetic at A site and presence of Co and Fe at B site creates a large difference between the net fields of A and B sites and results in large saturation magnetization.

Ni and Cu can replace Fe or Co at B sites. It is possible that they have replaced Co atoms, because in this way, the dipole moments due to Fe atoms would cancel and net uncompensated moment due to Ni can create some difference. This assumption will be verified later.

The coercivity is very important factor in defining the magnetic characteristics of a material. It is the field strength necessary to reverse the spin orientation direction [9]. The Wohlfarth model assumes that there is a uniform magnetization throughout the particle and it remains so throughout the rotation process [14]. Generally the energies required to reverse the spin orientation within single domain are larger than those needed in bigger ones so coercivity is larger in small particles. In other word, when particle size decreases to single domain, the domain rotation is preferred, consuming more strength of external field making coercivity high. At the blocking temperature, when thermal energy is sufficient to break the anisotropy barrier, the coercivity gets zero. Below this temperature, the coercivity is the field which together with thermal energy can overcome the anisotropy. Therefore coercivity increases with size, below blocking temperature [14].

In all the samples shown, as shown in figure 6, the coercivity is more at lower annealing temperature. This trend of ours verifies the established theories about dependence of coercivity with temperature.

X-Ray diffraction data, which we had obtained, was matched with ICDD (International centre for Diffraction Data), which indicated that the phases are pure, but small amount of impurities were present at 4500C, which were seen settled at high temperature. It may be due to their decomposition.

The $CoFe_2O_4$ sample had trace amounts of FeO, and Fe_2O_3, shown by lines at 33.162, 35.630, 49.465 degrees. At higher temperature these are negligible. $Cu_{0.1}Co_{0.99}Fe_2O_4$ sample was having oxides of iron in very little amount but at high high temperature the oxides are absent. In all the mixed ferrite we found that oxides of iron are more likely to be found as impurity at low temperature. At high temperature, the phases are more pure.

CONCLUSION:

It is clear that properties of Cobalt ferrite can be wisely tailored by addition of calculated amount of impurities in this. The atomic size and magnetic properties of mixed ferrite greatly depends on dopant atoms. At high temperature, the cobalt ferrite is more likely to be pure. In future, we shall dope high percentage of impurities to find out whether the trend continues or not.

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Table 1. Table of Cumulative data

450^{0}C				
Sample names	**Size nm**	**Sat. Mag. emu/g**	**Coercive field (G)**	**Rem. Magn.**
$CoFe_2O_4$	43.4	36.7	1460	19.5
$Cu_{0.1}Co_{0.99}Fe_2O_4$	61.3	42.4	1768.1	24
$Ni_{0.1}Co_{0.99}Fe_2O_4$	89.7	39.9	1321.3	19.5
$Zn_{0.1}Co_{0.99}Fe_2O_4$	40.6	41.7	1070.3	18.6
650^{0}C				
Sample names	**Size nm**	**Sat. Mag. emu/g**	**Coercive field (G)**	**Rem. Magn.**
$CoFe_2O_4$	46.5	41.4	654.1	16.8
$Cu_{0.1}Co_{0.99}Fe_2O_4$	73.8	66.1	755.9	26.35
$Ni_{0.1}Co_{0.99}Fe_2O_4$	73.8	60.9	510	17.8
$Zn_{0.1}Co_{0.99}Fe_2O_4$	44.8	64.6	432.3	16.7

Figure 2. XRD patterns of samples

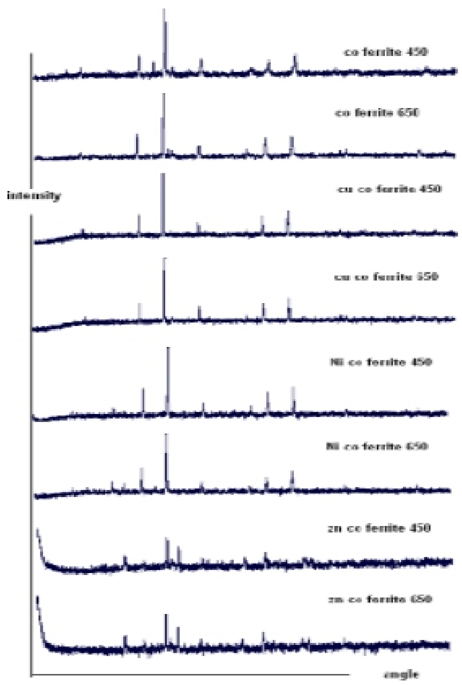


Figure 2. XRD patterns of samples

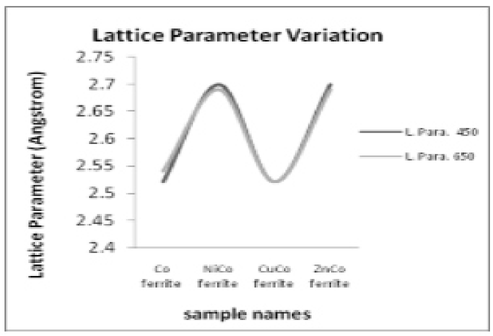


Figure 3 Hysteresis plots of samples annealed at 450^0 C

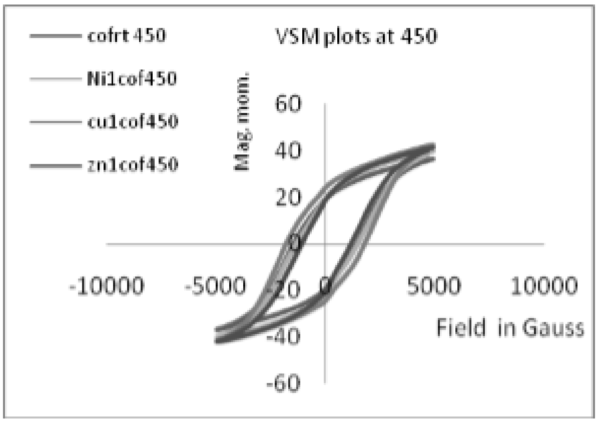


Figure 4 Hysteresis plots of samples annealed at 650^0C

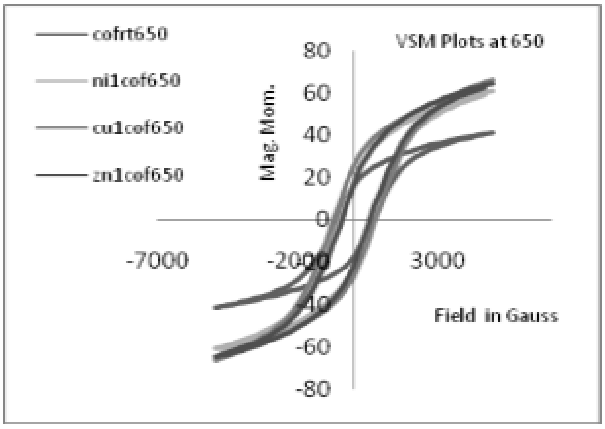


Figure 5. Variation of saturation magnetization

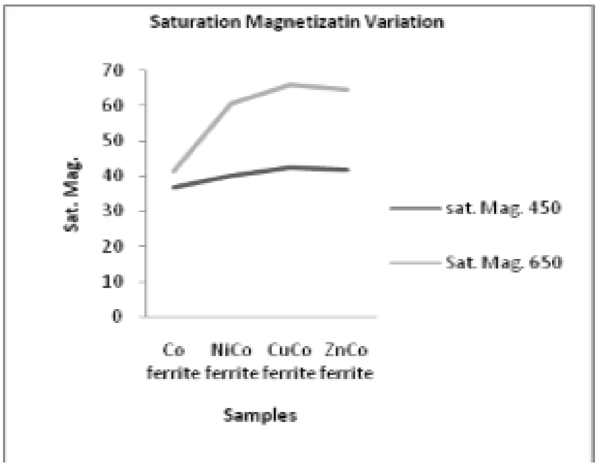
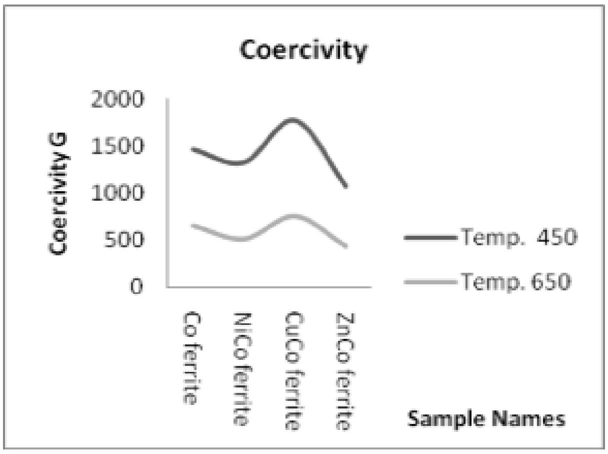


Figure 6 .Variation of Coercivity of samples



The Assessment of Development Impact Between the Dams of Floodpain Area on the Length of the Compression Region

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ABSTRACT

The article presents the results of experimental researches to assess the impact of development between the dams floodplain area on the length of the compression region.

Key words: Compound sections, development between the dams of floodplain area, coefficient of development, backwater, swirl of compression area.

INTRODUCTION:

In designing of many hydraulic structures and, first of all, which designed to effectively protect of the shores, it is very important to know the patterns of flow in compound sections. In the purpose of determining the influence of the development of inter-living space on the flow regime, in the case, when the interaction between channel and floodplain flows has a significant influence on the processes, experimental researches were carried out on the schematized model. The experiments were carried out in the laboratory of the department "Hydraulic engineering structures and engineering constructions" TIIM (Fig.1.).

Object, problem and research method. The model installation is a concrete hydraulic tray with rectangular sections of the bed and floodplain. The width of the one-sided floodplain is 0.85 m, the channel width is 0.30 m. The length of the working part of the tray is 12.5 m.

Experimental researches were carried out on the model under the following conditions: The degree of restriction of flow on the flow was changed

$$qq = Qпер / Q = 0...0,5$$

Where Qпер -consumption on the overlapped part of the floodplain in the domestic mode; Q is the total of rate of flow.

The coefficient of development of inter-cum-space is

$$Ko = l /(lШ \ sina) = 0 \ 1.0,$$

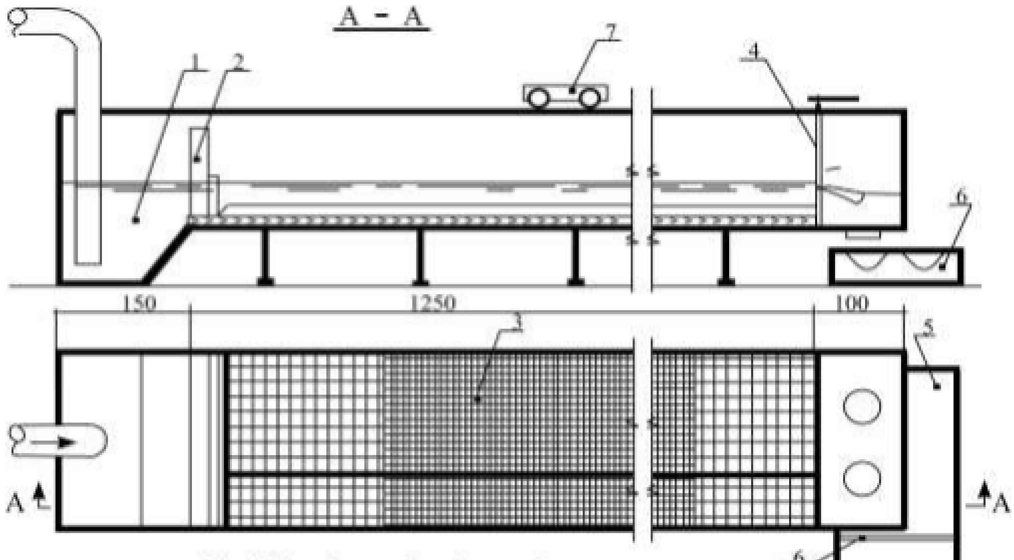


Fig.1. The schema of expiremental
1.Reservoir 2.Reduction of energy 3.Working part 4.Jalousie 5.Water well
6.Dimensional weir 7.Truck

where l Ш - is the length of the spur; l - width of development; Spur adjustment angle a = 300...1350 .

Relative interdigital distance

x = L /(lв + lн) = 0.5...1.0 ,

where L is the actual length of the section between the dams; lв - the length of the whirlpool; lн - the length of the bottom vortex.

Froude number in domestic conditions on the floodplain is less than 0.2 F < 0.2 п

The Reynolds number on the floodplain is more than 4000, in the channel of more than 10,000. the turbulent regime was maintained.

The carried out researches have been directed on studying of influence of the development of inter-mine floodplain space in compound sections on hydraulics of the deformed stream. During the research, the level and velocity regimes of the flow were measured in the tray, the planned dimensions of the deformed flow.

On the basis of experimental researches, the profiles of water level changes in dimensionless coordinates were constructed:

Δhi / hu = f

(S / bo ,θq,α , Ko ,ξ),

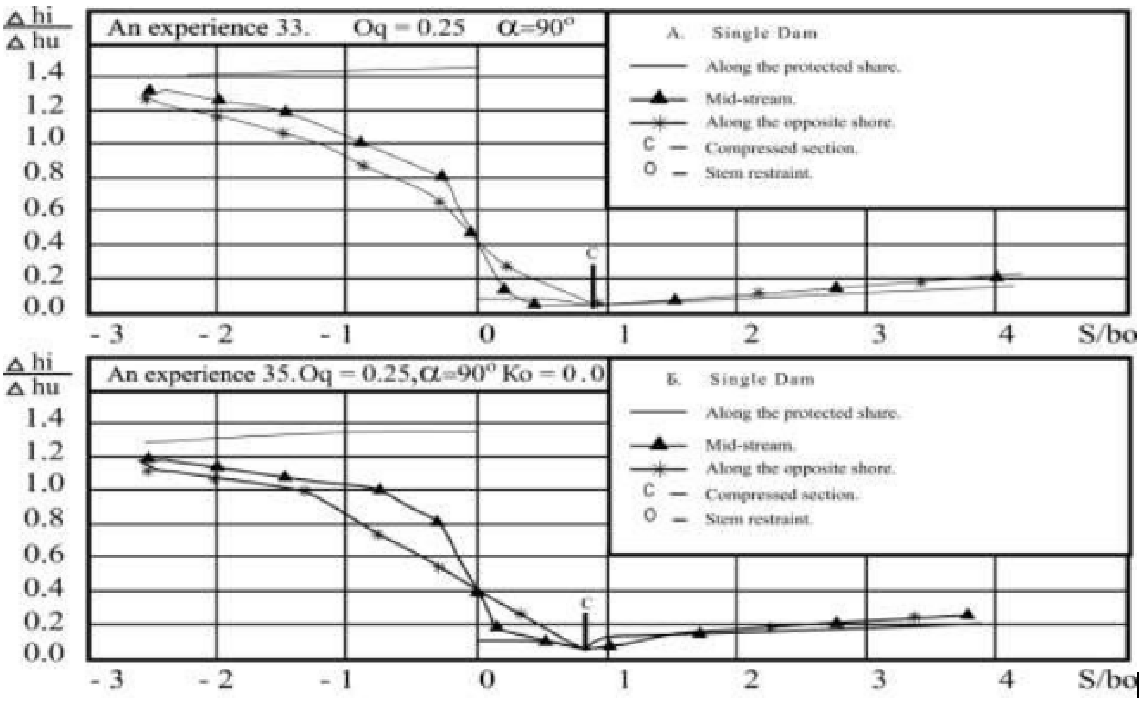
where hi

= hi – hc is the difference in water levels between the calculated and compressed cross- sections;

2 u ЯС / 2g - high-speed head in a compressed line;

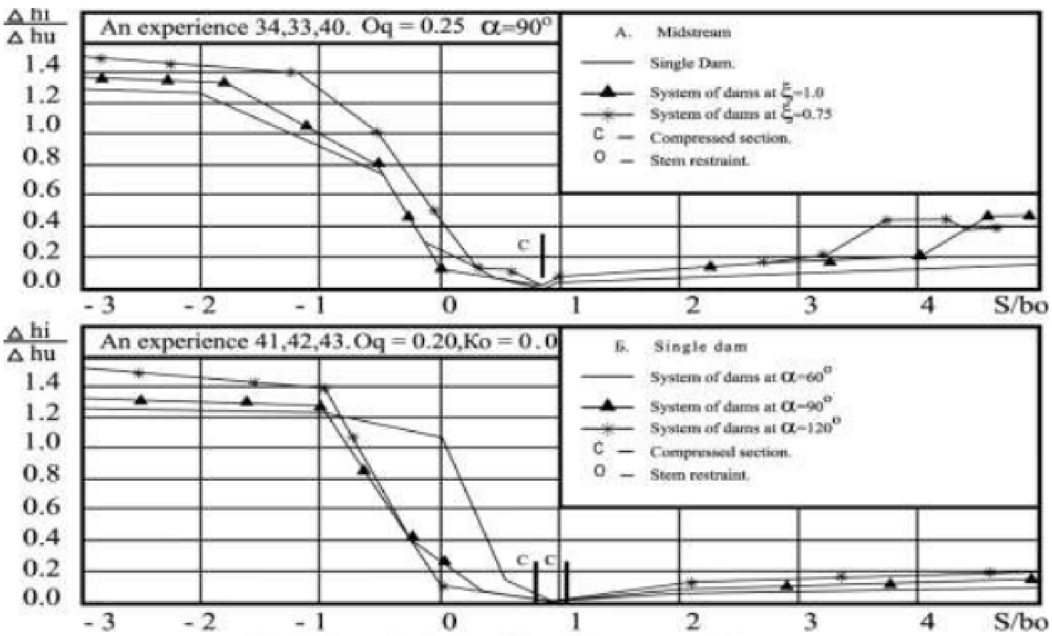
S-distance from the confines of restraint to the settlement line.

From Fig. 2, 3, 4. we can judge the nature of the change in the longitudinal and transverse differences in the levels of the flow deformed by the system of dams. In the region of the support, the resulting transverse changes in the water surface level deflect the streamlines from the shore, where the structure adjoins the opposite. In the range of restraint, the water levels of the transit flow are equalized. In the compression region, a transverse slope of the free surface of the water appears, which directed toward the protected shore. The transverse slope of the water surface in the spreading area is also directed towards the protected shore and practically is zero.



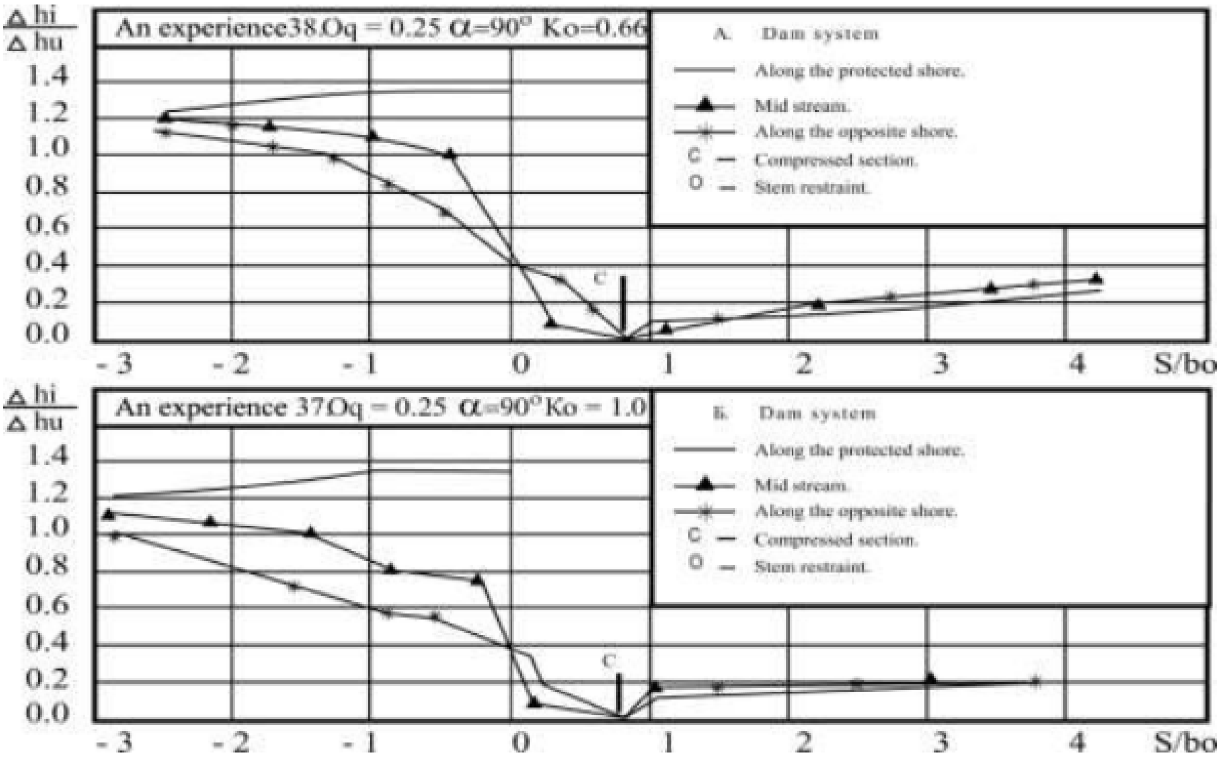
2. Longitudinal surface profiles

For a compressed cross section, with a free spreading of the deformed flow, the depth increases gradually. And in installing the dam system, under the influence of the underlying dam, the depth behind the compressed section increases more intensely Fig. 3, 4. In this case, the magnitude of the distance between the dams exerts a significant influence. The value of the backwater before the underlying dam varies in proportion to the distance between the dams.



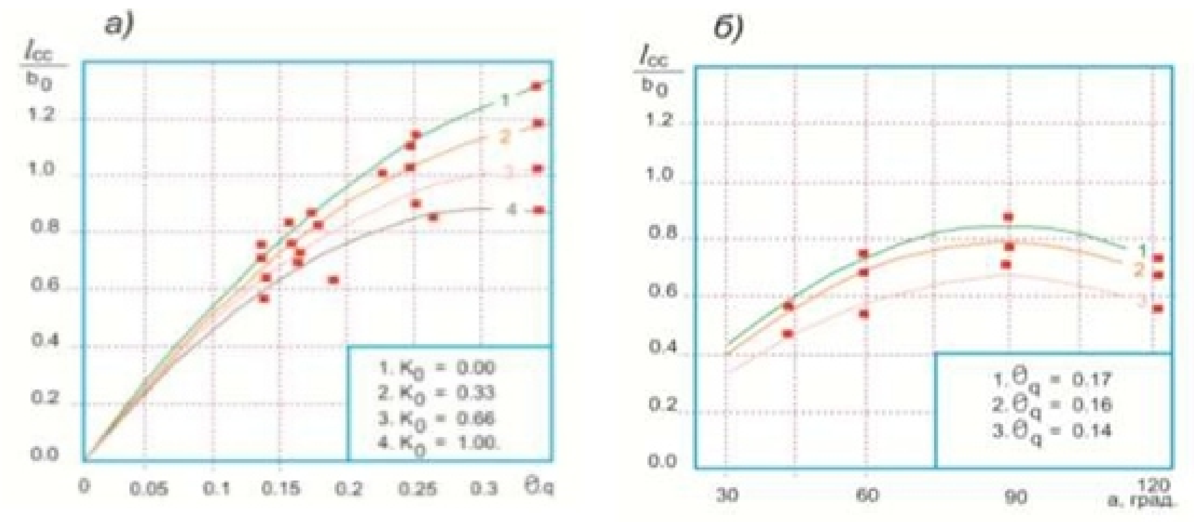
3. Longitudinal profiles of the water surface

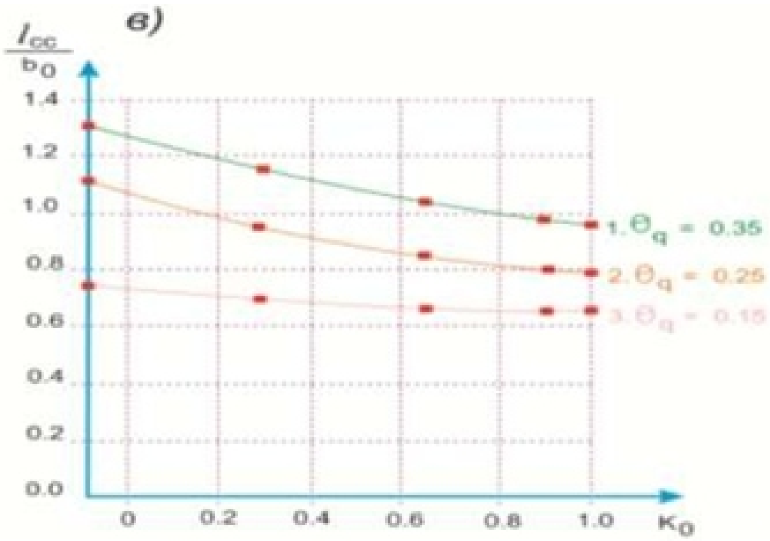
Reducing of this distance leads to an intensive increase in the depth of water in the spreading region. If the relative inter-mine distance is less than 0.5, the underlying dam falls into the area of the whirlpool.



4. Longitudinal profiles of the water surface

The location of the compressed section, in the experiments, was previously determined visually, with the help of bottom and surface floats, and then refined according to the velocity diagrams. Experimental data show that the location of the compressed section is mainly influenced by: the degree of constraint of the flow by the flow rate qq , the installation angle of the dam a, and the development factor of the intermodal floodplain space Ko. Analysis of graphical dependencies (Fig. 5) shows that with increasing the degree of constraint of the flow, the relative length of the compression region lcc / bo increases. The intensity of the increasing in the relative compression of the length is uneven.





At q q>0.24, the increment of the abscissas of the function decreases with constant increments of ordinates. And for Ko = 1.0, even a certain decrease in the value is observed for q q>0.3. Analyzing the influence of the development coefficient Ko, we can note that the influence of Ko is insignificant up to q q=0.1. With a further increase in the degree of restraint, the influence of the development factor increases. The relative length of the compressionq o oregion (lcc /bo) is described by the following analytical dependence:

$$l_{cc} / b_o = \left[(1{,}92K_o + 6{,}95)\theta_q^2 + (0{,}6K_o - 6{,}2)\theta_q\right]\sin(\pi + \alpha)$$

Where

lcc - is the length of the compression region;

bo - the width of the unrestricted flow in the constraint range

CONCLUSIONS.

The location of the compressed section is mainly affected by the degree of constraint on the flow rate of development θq installation of the dam α . of the intermodal floodplain space Ko , the angle of Increasing of θq leads to increase in the relative length of the compression region of lcc / bo , the increase of Ko leads to decrease of lcc / bo , while for the Ko = 1.0 values there θq > 0.3 is a slight decrease of lcc / bo . At the time of θq ≤ 0.1 constraint, Ko s influence on the lcc / bo insignificant, and the further increase of θq leads to decrease of lcc / bo .

An increase α to 900 leads to increase of lcc / bo with a further increase α in its decrease.

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