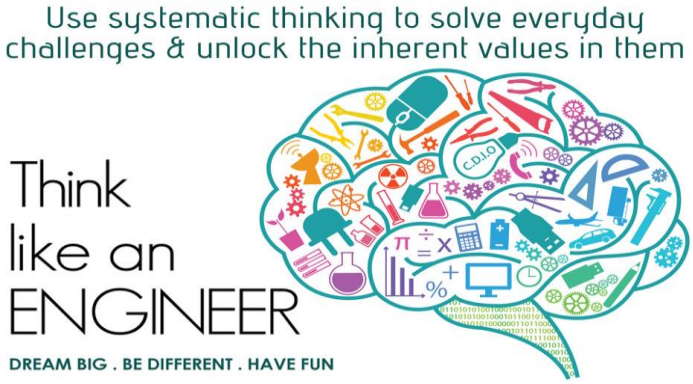
Half Yearly Magazine (Jan to May 2017)

RPTC TECHNICAL MAGAZINE

RANE TECHNO-VATE



LET'S TAKE THE FIRST STEP TO MAKE THE "SKILLFULL INDIA"…

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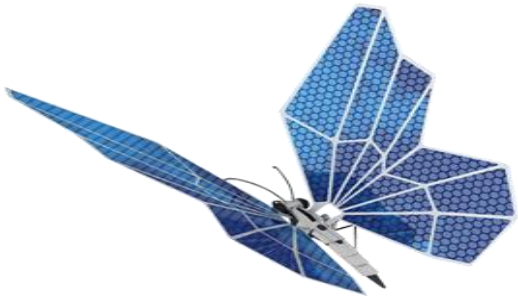

RANE POYTECHNIC TECHNICAL CAMPUS

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1.PHYTO CHEMICALS

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The plant kingdom is a rich source of potential drugs. In India medicinal plants are widely used by all sections of the population either directly in different indigenous systems of medicine or indirectly in the pharmaceutical preparation of modern medicine. Research on natural resources has been encouraged by the world health organization since 1978.'Phyto' is the Greek word for plant. *The plant kingdom is a rich source of potential drugs. In India medicinal plants are widely used by all sections of the population either directly in different indigenous systems of medicine or indirectly in the pharmaceutical preparation of modern medicine. Research on natural resources has been encouraged by the world health organization since 1978.'Phyto' is the Greek word for plant.*

There are many families of phytochemicals and they help in the human body in the variety of ways .Terpenoids found in green foods, soy products and grains comprise one of the largest classes of phytonutrients. Terpenes function as antioxidants, protecting lipids, blood and other body fluids from assault by free radical oxygen species.Flavonoids Apigenin found in chamomile,Quercetin in grapefruit,Rutin in buckwheat, Hesperidin in citrus fruits, silybin in milk thistle have action against allergies, inflammation, free radicals, platelet aggregation, microbes,ulcers,viruses and tumours. Flavonoids block the enzymes that produce estrogen and thus reducing the risk of estrogen reducing cancers. Cataracts can be a complication of diabetes because diabetics unable to metabolize sugar normally buildup damaging levels of ' alcohol sugars'. These in turn cause clouding of the lens of the eye. Flavonoids prevent cataracts by blocking 'aldose

reductase' a digestive enzyme which can convert the sugar galactose into the potentially harmful form of 'Galacticol'.

Phytonutrients of sulphur containing class are present in Garlic and cruciferous vegetables cabbage, turnips and members of the mustard family. Glucosinolates powerful activator found in cruciferous vegetables blocking enzymes that promote tumor growth particularly in breast , liver, colon, lung, stomach and esophagus.Medicinal plants are the nature gift to human being to make disease free healthy life. 'Cyperus Rotundus '.-Tamil Name – 'Korai Kizanghu' is a medicinal plant possess numerous health benefits. The phytochemical screening of the Rhizome showed the presence of Saponins,Flavonoids,phenolics,glycosides as well as cardiac glycosides,Anthraquinones and triterpenes.Cyperus is an ingredient in popular Ayurvedic formulas such as the herbal honey 'Chawanprash' and the womens blood tonic and uterine regulating formula 'Ashokarishta'.It may also be used as a single herb remedy for obesity,digestive problems and fevers.India is one of the most medico culturally diverse countries in the world where the medicinal plant sector is part of a time honoured tradition that is respected even today. Traditional medicine derive their scientific heritage from rich experiences of ancient civilization. India is well known for its rich traditional system of medicine i.e., Siddha, Ayurvedic, Unani besides a vast reservoir of living traditions of ethno medicine. The earliest mention of the use of plants in medicine is found in the Rigreda which was written between 4500 and 1600 BC.During British period due to western culture , Our traditional art of natural healing is disappeared Slowly. Now it is reappeared due to realization of its importance in curing disease without any side effect.

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2.TEACHING AND LEARNING METHODS IN HIGHER EDUCATION

S.Packiyaraj
Librarian

Quality teaching has become an issue of importance as the landscape of higher education has been facing continuous changes: increased international competition, increasing social and geographical diversity of the student body, increasing demands of value for money, introduction of information technologies, etc. A 'teacher' is a person who delivers an educational program, assesses student participation in an educational program, and/or administers or provides consistent and substantial leadership to an educational program. The group discussion is the best method of teaching because of; more participation of students, the learning is more effective, the students don't have to rely on rote learning, and this method develops creativity among students etc. Students' perception and ratings about the interesting and effective teaching methods is a way to suggest improvements in teaching / learning process. High quality teaching is widely acknowledged to be one of the key factors in achieving successful learning outcomes, by developing the knowledge, skills, attitudes and values that learners need in order to realize their full potential both as individuals and as active members of society and the workforce.

- ***Key words:*** *Teaching Method; Learning; Interactive Method; Education; Teaching; Seminar*

Meaning of Teaching :

Effective teaching is one that will bring about the intended learning outcome. Teaching is perceived as stimulating, directing, guiding the learner and evaluating the learning outcomes of teaching. Creating a situation or selecting life – like situation to enhance learning, Showing, telling, giving instruction, making someone understand in order to learn. Imparting knowledge and skills required to master a subject matter.

Teacher :

Person, who teaches, controls learning, dispenser of knowledge, an ultimate authority, a director of learning. a person or thing that teaches something; especially *: a person whose job is to teach students about certain subjects. A 'teacher' is a person who delivers an educational program, assesses student participation in an educational program, and/or administers or provides consistent and substantial leadership to an educational program. Give the learner the responsibility to learn "the decision maker in the teaching process"*

Good Teaching is :

- *Well planned and activities are interrelated*
- *Provides learning experiences or situation that will ensure understanding, application and critical thinking based on the theory of learning*
- *Where the learner is stimulated to think and reason*
- *Utilizes prior learning and its application to new situation*
- *Governed by democratic principles*
- *Embeds a sound evaluation process*

Teaching and Learning Methods.

In the process of learning it is impossible to learn any concrete issue by using only one method. The teacher has to use different methods during the teaching process; also a combination of methods is frequently used. In the process of teaching methods often supplement one other. The most widely spread teaching and learning methods as well as their definitions are given below. A teacher should choose the proper method according to the concrete aim and problem.

- ***Discussion/Debates :*** *This is the most widely spread method of*

interactive teaching. A discussion process greatly increases the quality of students' involvement and their activity. A discussion may turn into an argument and this process is not merely confined to the questions posed by the teacher. It develops students' skills of reasoning and substantiating their own ideas.

- ***Collaborative Work*** *; using this method implies dividing students into separate groups and giving each group its own task. The group members work at their issues individually and at the same time share their opinions with the rest of the group. According to the problem raised, it is possible to shift the functions among the group members in this process. This strategy ensures the students' maximum involvement in the learning process.*

- ***Problem - Based Learning (PBL) :*** *is a method which uses a concrete problem as the initial stage both for acquiring new knowledge and integration process.*

- ***Brain Storming:*** *this method implies forming and presenting as many radically different ideas and opinions on a given topic as possible. This method sets conditions for developing a creative approach towards a problem.*

- ***Demonstration Method :*** *implies presenting information with the help of visual aids. It is quite effective in reaching the required result. It is frequently advisable to present the material simultaneously through audio and visual. The material can be presented both by a teacher and a student. This method helps us to make different steps of perceiving the teaching material more obvious, specify what steps the students are supposed to take independently; at the same time this strategy visually*

shows the essence of an issue/problem. Demonstration can be very simple.

- ***Inductive Method :*** *determines such a form of conveying any kind of knowledge when in the process of learning the train of thought is oriented from facts towards generalization, i.e. while presenting the material the process goes from concrete to general.*
- ***Deductive Method :*** *determines such a form of conveying any kind of knowledge which presents a logical process of discovering new knowledge on the basis of general knowledge, i.e. the process goes from general to concrete.*
- ***Analytical Method :*** *helps us to divide the whole teaching material into constituent parts. In this way the detailed interpretation of separate issues within the given complex problem is simplified.*
- ***Verbal or Oral :*** *method comprises a lecture, narration, conversation, etc. During the process the teacher conveys, explains the material verbally, and students perceive and learn it by comprehending and memorizing.*
- ***Written Method :*** *implies the following forms of activity: copying, taking notes, composing theses, writing essays, etc.*
- ***Laboratory Method :*** *implies the following forms of activity: conducting experiments, showing video materials, etc.*
- ***Activity - Oriented Teaching : i****mplies teachers' and students' active involvement in the teaching process, when practical interpretation of the theoretical material takes place.*
- ***E – Learning :*** *implies using the Internet and multi - media means in the process of teaching. It comprises all the components of the teaching process (aims, content, methods, means, etc.); the realization of these components takes place through specific means. There are three types of e - learning:*

- *Full - time tuition; when the teaching process takes place during teachers' and students' contact hours, and conveying the teaching material occurs through an e - course;*
- *Distant learning implies conducting the teaching process in the absence of a professor. The teaching course is conducted distantly; in the e - format.*
- *Hybrid (full - time/distant) – teaching is mainly conducted distantly but a certain part of it is conducted during contact hour*

5 Highly Effective Teaching Practices

1. Teacher Clarity :

When a teacher begins a new unit of study or project with students, she clarifies the purpose and learning goals, and provides explicit criteria on how students can be successful. It's ideal to also present models or examples to students so they can see what the end product looks like.

2. Classroom Discussion :

Teachers need to frequently step offstage and facilitate entire class discussion. This allows students to learn from each other. It's also a great opportunity for teachers to formatively assess (through observation) how well students are grasping new content and concepts.

3. Feedback :

How do learners know they are moving forward without steady, consistent feedback? They often won't. Along with individual feedback (written or verbal), teachers need to provide whole-group feedback on

patterns they see in the collective class' growth and areas of need. Students also need to be given opportunities to provide feedback to the teacher so that she can adjust the learning process, materials, and instruction accordingly.

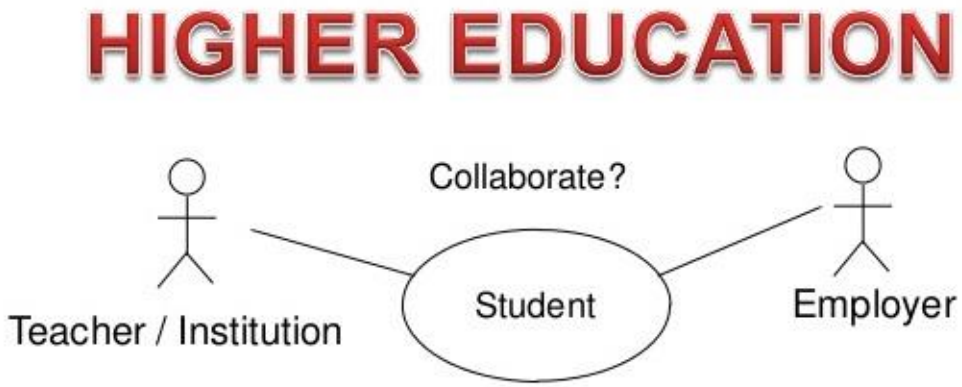
4. Formative Assessments :

In order to provide students with effective and accurate feedback, teachers need to assess frequently and routinely where students are in relation to the unit of study's learning goals or end product (summative assessment). Hattie recommends that teachers spend the same amount of time on formative evaluation as they do on summative assessment.

5. Metacognitive Strategies :

Students are given opportunities to plan and organize, monitor their own work, direct their own learning, and to self-reflect along the way. When we provide students with time and space to be aware of their own knowledge and their own thinking, student ownership increases. And research shows that metacognition can be taught.

Teaching and Learning Methodology :



Conclusion :

A fast changing world, the role of teachers - and the expectations placed upon them - are evolving too, as they face the challenges of new skills requirements, rapid technological developments and increasing social and cultural diversity, and the need to cater for more individualized teaching and special learning needs. High quality teaching is widely acknowledged to be one of the key factors in achieving successful learning outcomes, by developing the knowledge, skills, attitudes and values that learners need in order to realize their full potential both as individuals and as active members of society and the workforce. Higher education institutions providing initial teacher education could be strengthened as hubs for educating both teachers and teacher educators, and for conducting research into teacher competence development and effective teaching and learning methods.

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3.EXPERIMENTAL SETUP AND DESIGN ANALYSIS OF GLOBE VALVE

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In recent years, valve manufacturers across the world have focused their attention towards developing high performance globe valves design to outweigh the problems caused by the conventional globe. The valve manufacturers use FEA & CFD simulation tools to effectively optimize the design. This paper briefly explains the typical problems faced in the industry with the conventional globe such as the difficult manual operation due to higher valve torque, stem bending issues in stainless steel material, packing performance deterioration by rotating stem design, galling problems at stem threads and at flange bolts and gland packing eyebolts at low temperature. It also dealt on the common control valve parameters which degrade performance like cavitation problems leading to erosion, reduced flow capacity, flow separation & recirculation, pressure drop across the valve & Noise levels.

The problems with conventional globe designs were addressed by developing the high performance globe valve. These are designed to achieve high sealing performance with lesser hand wheel effort by the introduction of new features like non-rotating stem globe design, in-suite seat arrangement and seal-welding of threaded seat ring and guided disc arrangement. FEA and CFD tools are used to optimize the body-bonnet cover flange thickness, disc thickness and flow geometry.

Keywords: Galling, In-suite, Flow co-efficient, Cavitation, Pressure drop, CFD.

1. INTRODUCTION

Economic and environmental constraints dictate the need for the efficient performance of valves in stringent environments. Keeping this in mind, the globe & control valve designs were optimized using the latest software for FEA and CFD. Standard globe valves are used in throttling applications where the flow rate is moderately regulated by manually adjusting the disc positions whereas in control valves the flow is very precisely controlled by the automatically operated actuators in the closed loop system. The control valves have inherent flow characteristics that define the relationship between the valve opening and flow rate under constant pressure conditions.

Globe valves over a period of usage face several typical problems in the site like deteriorated packing performance, seat leakage, difficulty in operating the valve & stem bending problems in stainless trims and binding of yoke-sleeve and stem threads due to the galling process etc .This paper explains in detail about the various problems faced in the site along with the solutions to overcome such issues and also it talks about the new globe features that enhance product performance. The cost focus was also given to reduce the valve weight in view of the global concerns on cost reduction. Weight reduction is done by optimizing the various parameters like cover flange thickness optimization using FEA and CFD.

A control valve is a mechanical device that controls the flow of fluid and pressure within a system or process. A control valve controls system or process fluid flow and pressure by performing different functions like stopping and starting fluid flow, varying (throttling) the amount of fluid flow, controlling the direction of fluid flow, regulating downstream system or process pressure, relieving component or piping over pressure .There are many valve designs and types that satisfy one or more of the functions identified above. A multitude of valve types and designs safely accommodate a wide variety of industrial applications. Eight different models to represent the effect of friction in control valves are presented in [1].

The physical models, both static and dynamic, have the same structure. The models are implemented in SIMULINK/MATLAB and compared, using different friction coefficients *and input signals, whereas the details of design of stop valves which are commonly used as fluid flow control equipment in many engineering applications is performed [2]. Recently, CFD has been experiencing rapid advances due to both computer technology progress and efficient algorithms that have been developed to solve the Navier-Stokes (N-S) equations used in the flow analysis around ship hulls, the work contributed to the numerical solution of the viscous flow around ship-like bodies is discussed in [3]. An experimental and numerical of a three-dimensional, complex geometry, control valve was performed for model validation and improved understanding of valve flow features is discussed in [4]. The compressible air flow in a typical puffer chamber with moving contact between fixed electrodes has been studied using CFD techniques in [5]. Work to reduce the stiffness of the damper, so that the damper can withstand within the required constraints is related in [6]. Power plant system facilities are experiencing increasingly higher temperature and pressure conditions aimed at improving energy efficiency. Various valves are used to control flow in the power plant system. Valves used at a power plant are under high temperature, high pressure, and high differential pressure conditions. Therefore, erosion, hammering, vibration, noise, and damage may arise due to cavitation, flushing, and seat leakage. Turbine bypass valves play a very major roll in power plant applications.*

2. REVIEW OF GLOBE VALVE (CONVENTIONAL TYPE)

In recent years, the valve manufacturers across the world focused their attention towards developing high performance globe valve designs to outweigh the problems caused by the conventional globe.

Typical problems faced in the industry with conventional Globe:

- *Higher valve torque due to the high thrust force acting on the disc.*
- *Difficult manual operation.*
- *Stem bending problems more prominent in stainless steel material.*
- *The high frictional forces at the stem threads & yoke sleeve collar faces leads to high torque and shortens valve life.*

- *Rotating stem design deteriorates the packing performance at fewer cycles.*
- *Improper selection of stem and yoke-sleeve material resulting in galling.*
- *Stem binding due to galling with the mating components.*
- *Gland packing leaks –not meeting fugitive emission requirements.*
- *Galling of flange bolts and gland packing eyebolts at low temperature.*
- *Threaded seat ring design leaks at high pressure applications.*

3. GLOBE VALVE OPTIMIZATION AND ITS TRENDS

The conventional globe designs were modified to address the above problems and also redesigned to meet the stringent requirements of the customer like achieving tight sealing performance with lesser operator force and fugitive emission requirements. Apart from redesign, these components were also optimized for weight reduction by using FEA tool. The performances of the globe valve design are enhanced by the introduction of the following new features:

Globe Valve New Design Features:

- *Non-rotating globe design arrangement significantly reduces the valve torque.*
- *The fugitive emission service requirements are met by eliminating the packing erosion caused by the stem rotation.*
- *In-suite seat arrangement (Integral body seat design) and seal-welding of threaded seat ring eliminates the leakage through the seat threads.*
- *Guided disc arrangement and selection of high strength stem material avoids the stem bending problem as well improves the sealing performance. Body-bonnet cover flange thickness and disc thickness optimization using ASME calculations and FEA simulation.*
- *Validation of theoretically determined flow coefficient (Cv) against the CFD simulation method.*
- *Introduction of needle roller/thrust ball bearing at the yoke-sleeve collar faces reduces the friction. Also the introduction of washers and application of proper lubricants at nut surfaces helps to reduce the galling of bolts.*

Selection of proper material of stem and yoke-sleeve avoids galling in the threads. The new taper seat angle reduces the seating thrust and hence the torque.

- *Disc seat contact at the bottom for tight shut-off*

3.1 NON-ROTATING STEM DESIGN:

The conventional rotating type globe designs have more difficulties in manually operating the valve due to higher valve torque. This problem is addressed by converting from rotating to non-rotating type stem design. This helps in reducing the valve torque by 15% to 25% when compared with that of the rotating stem design due to the elimination of packing frictional torque. The anti-rotating device across the stem flat prevents the stem rotation and allows only the guide support to linear travel through the slot guide provided in the bonnet. The fugitive emission requirements are easily met by preventing the stem rotation and also the packing life is enhanced by minimizing the packing erosion.Figure.1 and Figure.2 shows the arrangement of non-rotating stem design and the anti-rotating device.

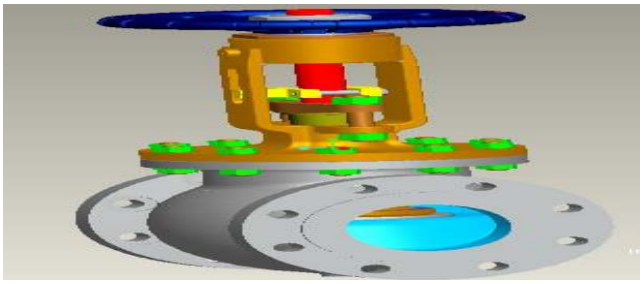

Figure 1

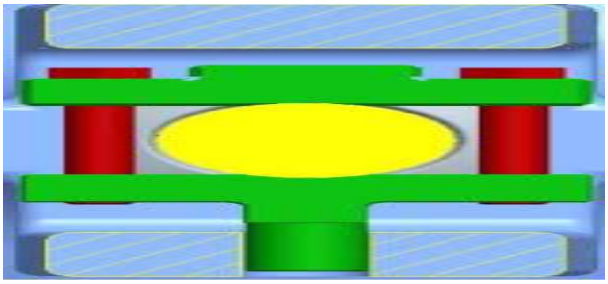

Figure 2

3.2 DISC SEATING TAPER ANGLE:

Disc sealing force is the force which is exerted on the disc against the seating surface to have tight shut-off. The sealing force can be reduced by changing the taper seat angle from 30 to 20 degrees as the force component vector depends on the seating angle. The figure.3 depicts the disc taper angle.

$$F = 3.14 \times Ds \times W \times P \times SIN\ (A+B)$$

Where F = Seating force Ds = Diameter of seat ring bore W= Width of the

disc contact area.

P= Fluid pressure A= Seat angle B= Friction angle.

In the above formula when "A" is changed from 30 to 20 degrees, the sine component reduces and hence the disc sealing force.

3.3 BODY GUIDED DISC TYPE:

In this arrangement, the disc is very closely guided along the ribs provided in the body, during the valve opening and closing. This supporting rib reduces the alignment variations caused by the bending of the stem. Also it takes up the bending load that comes on the stem when the hand wheel is over-tightened and also it resists the side thrust exerted on the disc. This guiding arrangement provides effective sealing of the disc by the effective transmission of the hand wheel force to the disc. The figure.3 &4 shows the body guided ribs.

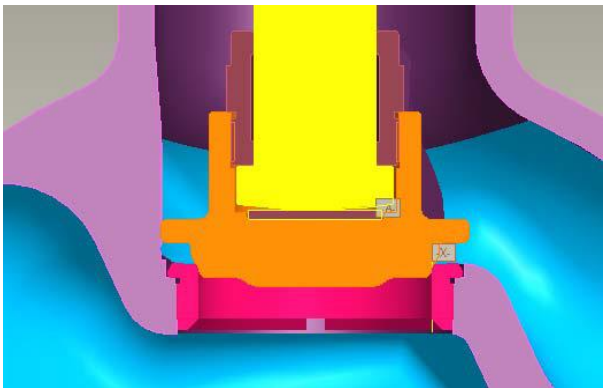

Figure.3

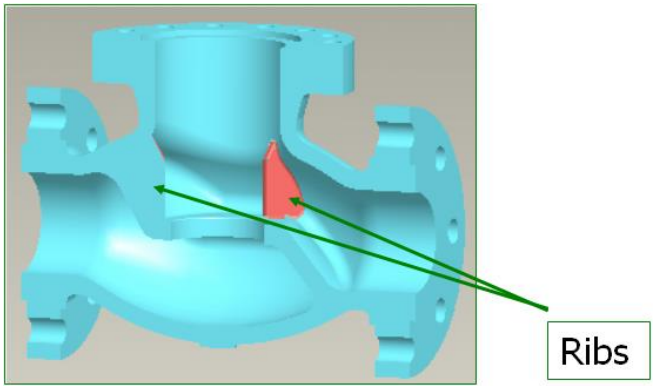

Figure.4

3.4 IN-SUITE SEAT RING:

This design provides integral seat ring on the body itself by directly depositing the satellite over the base material. This enhances alignment control within closer limits between the seat and disc during the valve closure. This also ensures uniform contact of the disc over the seat surface and thereby reduces the possible leakage path caused by non-uniform wear on the disc. This is generally used for large size valves where the sealing force is high.

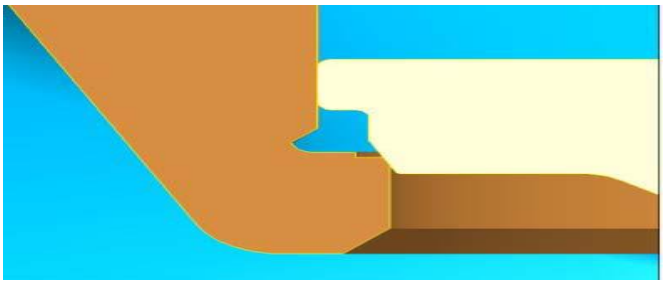

Figure .5

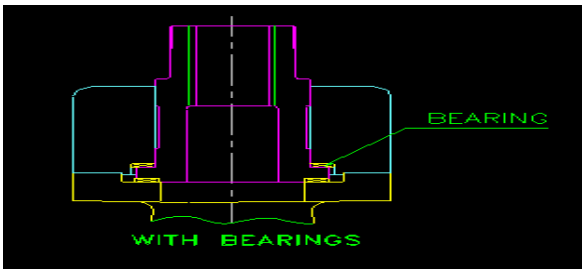

Figure .6

3.5 INTRODUCTION OF THRUST / NEEDLE ROLLER BEARING:

The thrust taking roller bearings are introduced on either side of the collar face of the yoke-sleeve of the gate valve to take up the axial thrust load. In the absence of the bearing, this load acts on the yoke-sleeve face and produces high frictional force, which is compensated by providing additional force on the hand wheel. The introduction of this bearing reduces frictional force developed between yoke sleeve faces and hence easier the operation of hand wheel.

The figure.4 shows the bearing on either of collar faces. Figure.6

3.6 ALUMINUM BRONZE YOKE-SLEEVE MATERIALS:

A high frictional force is generated between the stainless steel stem and nodular cast iron yoke-sleeve acme threads due to the wear of soft SS stem by the harder yoke-sleeve material. This frictional force is reduced by the introduction of aluminum bronze yoke-sleeve material, as it is a good self-lubricator and also has better anti-galling property. This reduction in force reduces the operator effort and hence makes the operation easier.

3.7 DESIGN OPTIMIZATION – USING FEA

Finite element analysis is done on the pressure subjected components like body, bonnet & disc using FEA package. Structural analysis ensures that the stresses and deflection induced are within the allowable limits. The pressure loads are applied on the body and disc surfaces exposed to the line fluid and also bolting load is applied on the body & bonnet bolting spot face area. These

give the realistic picture of how the valve behaves under the pressure conditions. Fixed constraints are given on the end flanges of the body to stimulate that it is fixed on the pipe flanges. The Figure 7, 8 & 9 shows the FEA analysis on body, bonnet & disc. The body stress plots shows that the maximum stress induced is 14000 psi, which is less than allowable stress of 20000 psi for stainless material. Similarly the disc stress and strain induced are within the allowable limits. The fringes of red color is the maximum value and blue is the minimum value induced.

3.8 COVER FLANGE THICKNESS OPTIMIZATION – FEA

The Body-Bonnet flanged joint flange thickness is calculated by using the ASME SECTION VIII calculations. After the developments of CAD/CAE software, the valve industries started realizing that the ASME calculations were excessively conservative due to the more factor of safety on the mechanical strength which is inbuilt in the ASME approach of design by codes. The designs are validated using the ASME calculations and also by FEA. The FEA analysis gives the opportunity for optimizing the flange thickness further to meet the demands of the market on reducing the weights for cost reduction.

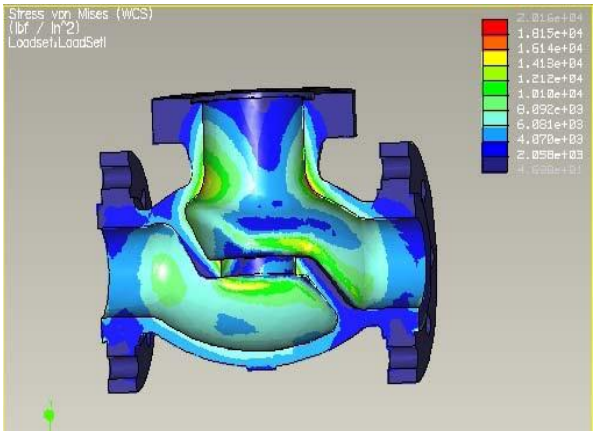

Figure.7

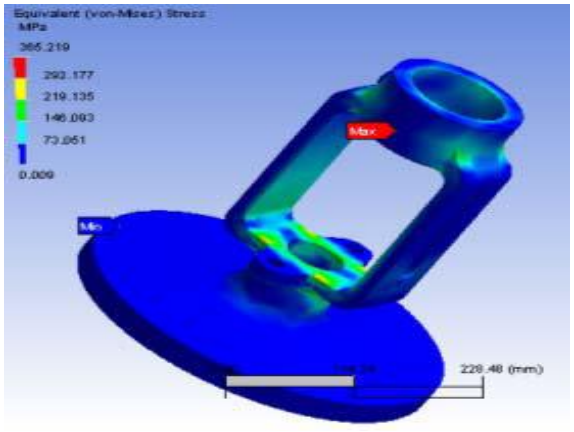

Figure.8

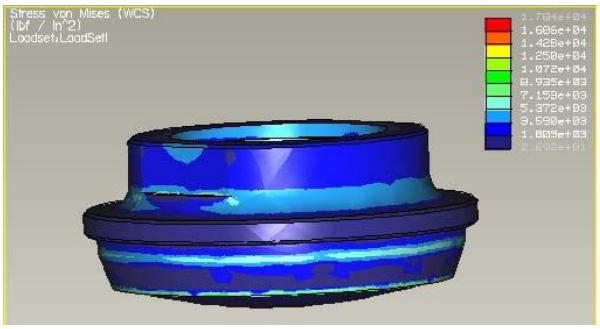

Figure.9

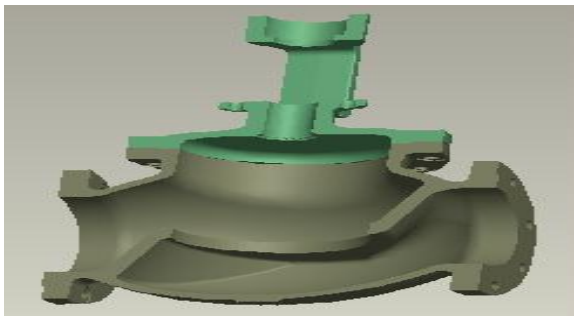

Figure.10

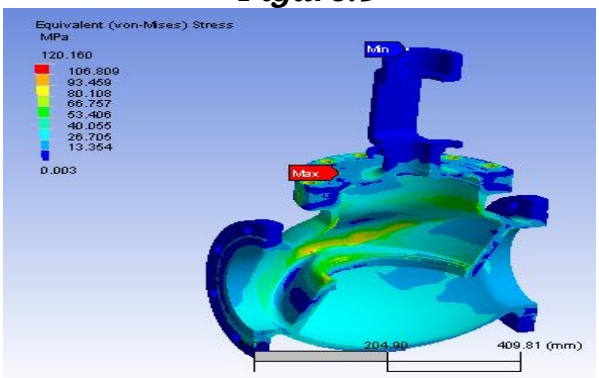

Figure.11

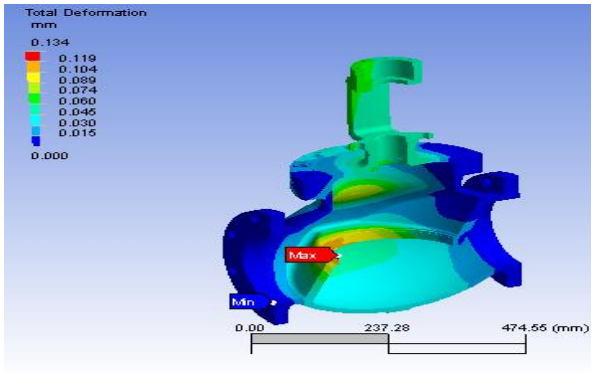

Figure.12

The weight reduction along with the enhanced performance made the product always to be competitive in the market. The ASME calculations and the FEA results are compared and analyzed for the optimized flange thickness. The FEA accurate interpretation of the results gives the designer a better opportunity for optimizations. In this analysis each single load can be detailed and the possibility to include the real and also non- inner bolts and gasket behaviour gets the loads. The real geometry can be taken into account including the uni-lateral contacts, material non-linarites and hub geometry.

	Valve	***Stress Type Design by***	***Code***	***Design by***	***FEA***
Stresses in Mpa	*8"*	*Longitudinal in hub ,SH*	*130*	*80*	*62*
		Radial in flange SR	*111*	*62*	*56*
		Tangential in flange ST	*43*	*22*	*51*

The above comparison shows that the design by code and design by analysis predict that the ASME is excessively conservative and design by analysis can be applied to get an optimized design with consistent material, machining and cost saving. The above results shows that the flange thickness can be reduced by another 40-50% and this will lead to a significant weight reduction. The Body- Bonnet cover flange optimization in 8" cl 150 Globe valve results in 10% weight reduction. The figure 11-14 shows the body-bonnet assembly, stress and deflection plots.

4. EXISTING PROBLEM IN GLOBE VALVE

In recent years, the valve manufacturers across the world focused their attention towards developing high performance globe valve designs to outweigh the problems caused by the conventional globe. Typical problems faced in the industry with conventional Globe valves are; higher valve torque due to the high thrust force acting on the disc, difficult manual operation, stem bending problems more prominent in stainless steel material, the high frictional forces at the stem threads and yoke sleeve collar faces leads to high torque and shortens valve life, rotating stem design deteriorates the packing performance at fewer cycles, improper selection of stem and yoke-sleeve material resulting in galling, stem binding due to galling with the mating components, gland packing leaks –not meeting fugitive emission requirements, galling of flange bolts and gland packing eyebolts at low temperature, threaded seat ring design leaks at high pressure applications.

Problem discussed in this paper is about difficulty in manual operation and controlling flow of fluid. Steps carried out in order to overcome the problem:

Identification of problem, Problem statement, Solid modeling, Flow analysis using CFD software to find Cv, selection of appropriate model from CFD results, manufacturing of model, testing of actual valve to find Cv, comparison of CFD values and testing values. Valve types are used to describe the mechanical characteristics and geometry (Ex/ gate, ball, globe valves). We will use valve

control to refer to how the valve travel or stroke (openness) relates to the flow. Before that we have to decide valve control to be used. Here are some rules for selection of control valve as shown in Figure 13.

1. Equal Percentage (most commonly used valve control)

- *Used in processes where large changes in pressure drop are expected*
- *Used in processes where a small percentage of the total pressure drop is permitted by valve*
- *Used in temperature and pressure control loops*

2. Linear

- *Used in liquid level or flow loops*
- *Used in systems where the pressure drop across the valve is expected to remain fairly constant (i.e. steady state systems)*

3. Quick Opening

- *Used for frequent on-off service*
- *Used for processes where "instantly" large flow is needed (i.e. safety systems or Cooling water systems)*

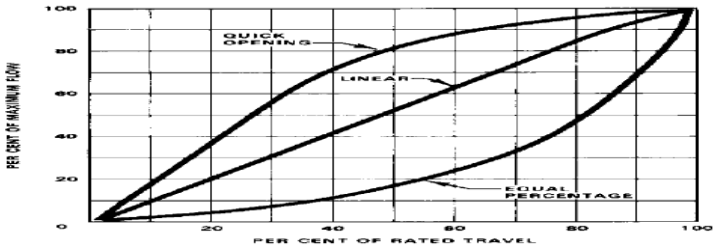

Figure 13 .Valve characteristics curves Flow coefficient Cv

The flow coefficient of a device is a relative measure of its efficiency at allowing fluid flow. It describes the relationship between the pressure drop across an orifice, valve or other assembly and the corresponding flow rate Mathematically the flow coefficient can be expressed as: Where; Cv = Flow coefficient or flow capacity rating of valve. F = Rate of flow (US gallons per minute). SG = Specific gravity of fluid (Water = 1). ΔP = Pressure drop across valve (psi). In more practical terms, the flow coefficient Cv is the volume (in US

gallons) of water at 60°F that will flow per minute through a valve with a pressure drop of 1 psi across the valve. The use of the flow coefficient offers a standard method of comparing valve capacities and sizing valves for specific applications that is widely accepted by industry.

5. PROBLEM DEFINITION AND OBJECTIVE

In this work, problem presented is of modifying the existing plug and seat arrangement of the globe valve, such that it should control the flow of fluid up to maximum permissible lift ranging from 2mm to 16mm to obtain the optimum range of fluid flow. The current plug and seat arrangement of globe valve is according to quick opening characteristics. For small lift of plug gives large flow. The main objective of this work is to analysis the plug and seat arrangement using Computational Fluid Dynamics to obtain proper flow control of fluid in given range of lift of plug. The inputs given are inlet pressure of about 40 bar, controlling discharge is 15m3/hr, and total pressure drop across the valve is 1 bar. Solid Modeling of plug and seat To perform CFD analysis of any component, the solid model of the same is essential. It is also called body in white. Fig. 14 and Fig. 15 show a solid model of damper.

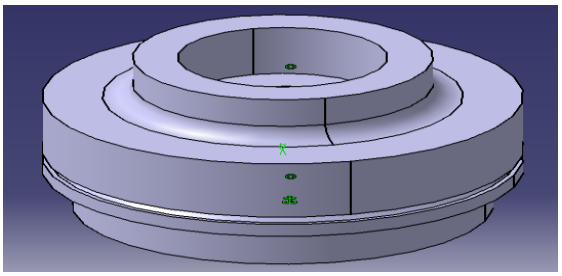

Fig. 14 Assembly of plug and seat

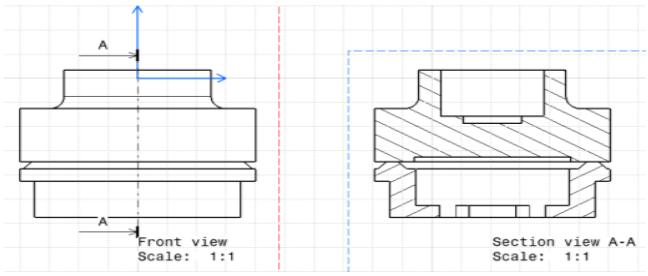

Fig.15Front View and Sectional View of Assembly

6. COMPUTATIONAL FLUID DYNAMICS

Computational fluid dynamics, usually abbreviated as CFD, is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyse problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers,

better solutions can be achieved. On-going research yields software that improves the accuracy and speed of complex simulation scenario such as transonic or turbulent flows.

Methodology: *Required parts are first modeled in CATIA & PRO/E WILDFIRE which are excellent CAD software's, which makes the modeling easy and user friendly. The model is then transferred in IGES format and exported into the Analysis software CFD 11.0. The assembly is analyzed in CFD in three steps. Pre-processing: The geometry (physical bounds) of the problem is defined. The volume occupied by the fluid is divided into discrete cells (the mesh). The mesh may be uniform or non-uniform as shown in Fig 16 and Fig 17. The physical modeling is defined. Boundary conditions are defined as shown in Fig 6. This involves specifying the fluid behavior and properties at the boundaries of the problem. For transient problems, the initial conditions are also defined. The simulation is started and the equations are solved iteratively as a steady-state or transient. Finally a postprocessor is used for the analysis and visualization of the resulting solution.*

Boundary Element Method

The boundary element method (BEM) is a numerical computational method of solving linear partial differential equations which have been formulated as integral equations. It can be applied in many areas of engineering and science including fluid mechanics, acoustics, electromagnetic, and fracture mechanics.

The integral equation may be regarded as an exact solution of the governing partial differential equation. The boundary element method attempts to use the given boundary conditions to fit boundary values into the integral equation, rather than values throughout the space defined by a partial differential equation. Once this is done, in the post-processing stage, the integral equation can then be used again to calculate numerically the solution directly at any desired point in the interior of the solution domain.

The boundary element method is often more efficient than other methods, including finite elements, in terms of computational resources for problems where there is a small surface/volume ratio. Conceptually, it works by constructing a "mesh" over the modeled surface. However, for many problems boundary element methods are significantly less efficient than volume-discretization methods.

Boundary element formulations typically give rise to fully populated matrices. This means that the storage requirements and computational time will tend to grow according to the square of the problem size. By contrast, finite element matrices are typically banded and the storage requirements for the system matrices typically grow quite linearly with the problem size. Compression techniques can be used to ameliorate these problems, though at the cost of

added complexity and with a success-rate that depends heavily on the nature of the problem being solved and the geometry involved.

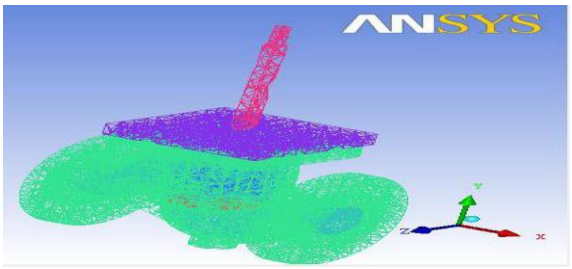

Fig.16 Mesh Assembly

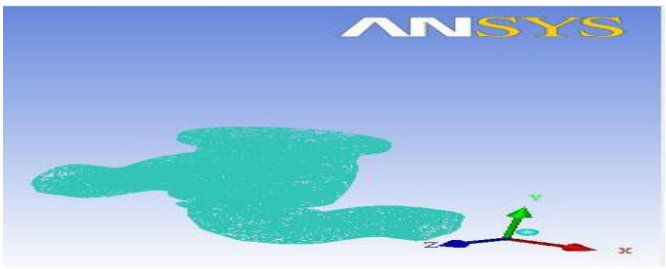

Fig.17 Volume Fluid mesh

7. SOLID MODELING AND CFD FLOW ANALYSIS

In this section different CATIA models and profiles of plug and seat are explained and these models then assembled in globe vale. These assemblies are then checked on CFD to calculate velocity for each 4mm lift. From this velocity Cv for each 4mm lift is obtained. Total 3trails are conducted for each different model.

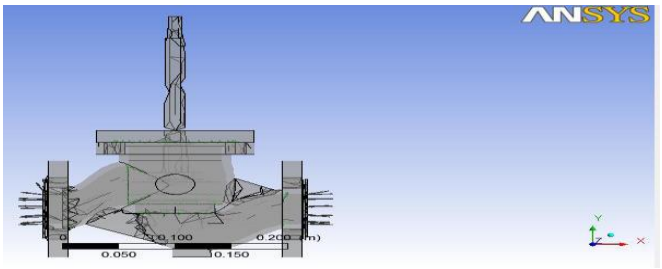

Fig.18 Boundary Condition

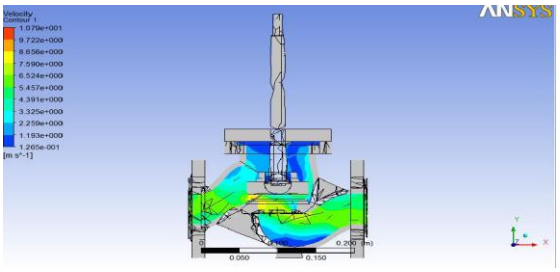

Fig.19 CFD analysis result for Trial 1

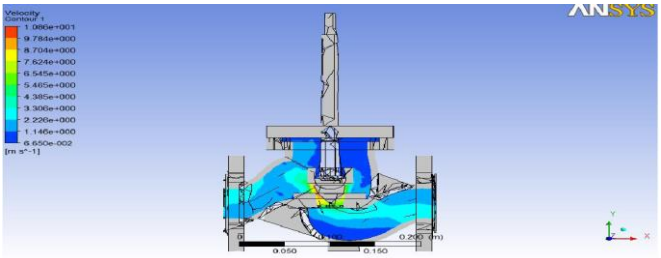

Fig.20 CFD Analysis result for Trial 2

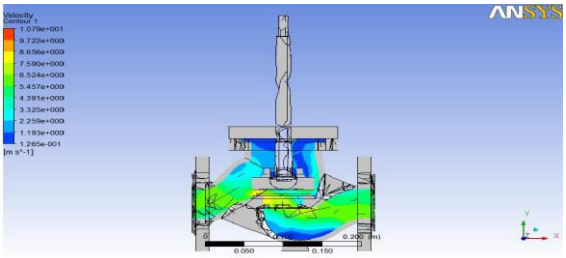

Fig.21 CFD Analysis result for Trial 3

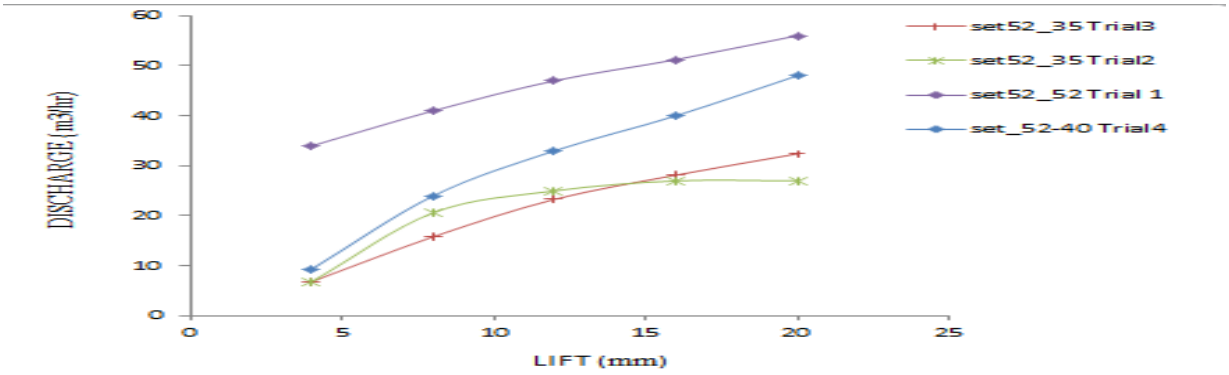

Fig.22 Discharge VS Lift Characteristic Curve

Trial 1. For plug of diameter 52mm and seat of diameter 52mm Solid Model of plug and seat is shown in Fig.18 and Fig.19 CFD: boundary conditions (common to all trials) Inlet condition- 40bar Outlet condition-39bar Solution- outlet velocity Q=Area × Velocity

Table.1 Result for Trial 1

Lift of plug(mm)	Outlet Velocity(m/s)	Outlet Discharge Cv(m3/hr)
4	4.449	34
8	5.457	41
12	6.244	47
16	6.7	51.22
20	7.31	56

Table.2 Result for Trial 2

Lift(mm)	Velocity(m/s)	Discharge(m3/hr)
4	0.9	6.88
8	2.7	20.64
12	3.157	25
16	3.478	27
20	3.478	27

Table.3 Result for Trial 3

Lift(mm)	Velocity(m/s)	Discharge(m3/hr)
4	0.9	6.88
8	2.071	15.83
12	3.049	23.31
16	3.681	28.14
20	4.23	32.397

8. STRUCTURAL ANALYSIS

The structural analysis was performed for the designed tortuous path disc using a commercial FEM code, ANSYS. Inconel 718 was selected as the material for the disc. The number of elements was 163 661 and ten-node tetrahedral structural solid elements were used .A pressure of 96 bar, which was the inlet pressure condition of steam, was applied to the inside of the disc and walls and the bottom and top surfaces of the flow path of the disc. The top and bottom surfaces, except for the flow path of the disc, were fixed in the z-direction. Bolting parts were fixed in all directions. The maximum stress on the disc was 289.67MPa; Figure 23 shows the FEM model and the result of the maximum stress. The maximum stress was significantly lower than the yield

stress(1035MPa) and the stress were stable as well.

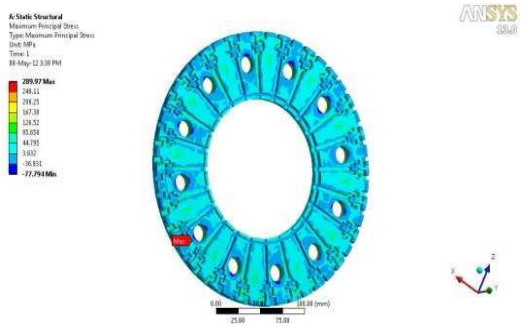

Fig.23 Maximum Principal stress

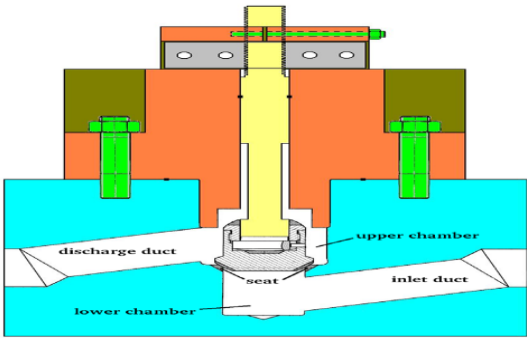

Fig.24Spotting cavitation influence

9. THERMO-MECHANICAL COMPUTATIONS

Thermal shock modelling projection

Results of the thermal computation were imported inside Code Aster FEM Solver, and temperature fields projected on the mesh designed for thermo mechanical study. Computation of one time step took about 1 hour on a single workstation. Parallelism was not used since it won't be useful in a problem involving unilateral contact. As the problem has a symmetry on the XY plane, only half of the valve will be modelled (the one with Z<0). Consequently, only 6 (among 12) threaded rods will be included in the modelling of the BBBFJ.

Transient description issues

Each thermal shock took about 30 time steps to be mechanically "correctly" described. It is worth noting that "correct description" of mechanical fields during such thermal transients consists of choosing the time steps adequately so that they allow representing local maximums of the value of interest on a temporal point of view. This aspect is negligible when dealing with "reasonable" quantities of data, but becomes critical when a computational need reaches hardware limitations. This implies that the process is iterative, since you don't know a priori *the temporal evolution of the result, and you can't afford to multiply time steps. The same issue arises when trying to determine the transient duration. This was treated by calculating the thermal field at equilibrium separately, and*

stopping computation when thermal transient approaches the equilibrium state.

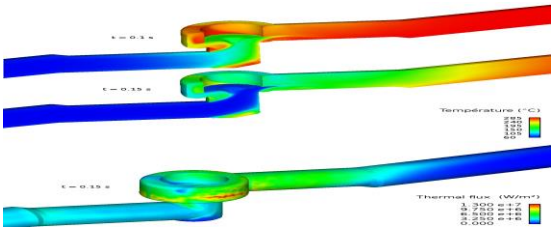

Fig. 25: CFD results. Temperature inside fluid at the beginning of a cold shock and resulting thermal flux (solid to fluid).

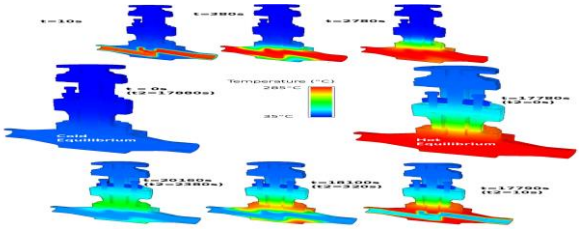

Fig.26: Thermal computation results. Temperatures maps during a full alternate shock

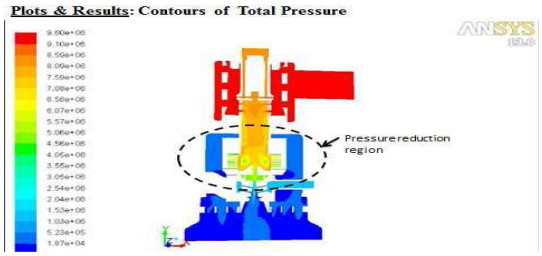

Fig. 10: Contours of Total Pressure

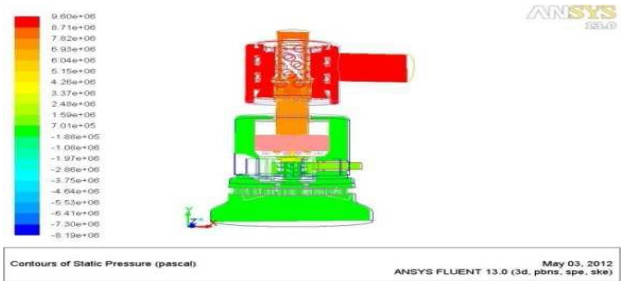

Fig. 11: Contours of Static Pressure

10. DETERMINING THE FLOW CO-EFFICIENT (CV)

Two important control valve parameters are the overall flow coefficient Cv and the relative valve capacity factor Cd. In general the calculation methods for Cv area function of the valve Reynolds number, Rev. The flow coefficient Cv is a measure of the valve capacity.

It is given by the ISA standard - ANSI-ISA-S75.02. The flow co-efficient is the designing factor which relates the pressure drop (Δp) with the flow rate (Q).It is the Water average flow coefficient in US Gallons per minute (GPM) crossing the valve with a pressure loss Δp of 1 PSI at 60° F. The Cv is a dimensional quantity that has evolved through industry usage. In the English Engineering System of units the Cv is simply the number of gallons per minute of water that can flow

*through the valve with a pressure drop of one pound per square inch. [**10**] However, in System International units this definition would not apply. Despite the somewhat ambiguous meaning of Cv, it has proven to be an acceptable indication of valve capacity. In the SI system the units of Cv are(m³/hr)/(Kpa)0.5*

11. PERFORMANCE TEST

Performance tests were performed with the valve installed inside the designed trim to check performance under the operating conditions. Experimental set-up and methods were performed by standards ISA-75.19.01, FCI 70- 2, and IEC 60534-2-3 as listed in Table 1.The pressure transducer used for the test was a bourdon gauge type. A capacitance sensor-type manometer was used for the measurement of the differential pressure. A thermocouple and temperature transmitter was used as a thermometer. An orifice flow meter was used to measure steam flow rate. Temperature compensation was carried out to measure exact flow rate of the steam.

The test results are shown in Table 1.

Referred Test items	*Mass flow rate 115 000 kg/h*	*Inlet/outlet pressure 96/5 bar*	*Differential pressure 91 bar*	*Inlet temperature 534*	*Required capacity 127.09*	*Opening travel % stroke 50*	*Seat leakage 0 l/min*	*Pressure rating 226 bar, 5 min*
11500 kg/h	*96/5 bar*	*91 bar*	*Inlet temperature 534*	*Required capacity 127.09*	*Opening travel % stroke 50*	*Seat leakage 0 l/min*	*Pr. rating 226 bar, 5 min*	-
ISA	*75.19.01 IEC*	*2*	*3*	*ISA*	*75.19.01 IEC*	*2*	*3*	*ISA*

12. RESULTS AND DISCUSSION

In Fig.22 it is seen that during Trial 1- discharge varies from 34 m3/hr to 56m3/hr, when lift varies from 4mm to 20mm. From this it is seen that for small lift of plug 34 m3/hr discharge is obtained and for full opening 56 m3/hr discharges is obtained. If actuator is placed over the Globe valve, hunting of actuator will take place. Hence it is difficult to control the fluid flow. As per Fig.22 it is seen that trial 1 and trial 3 curves generally matches quick openings characteristics. As per trial 2 - discharge varies from 6.88m3/hr to 27m3/hr, when lift varies from 4mm to 20mm.

It is cleared that discharge increases rapidly initially upto 10mm lift, but later when lift increases upto 20mm, the discharge increases slowly i.e. at 20mm lift upto 27m3/hr. As per trial 3 discharge varies from 6.88m3/hr to 32.397m3/hr, when lift varies from 4mm to 20mm.

Again it cleared that, if actuator is placed over the Globe valve, hunting of actuator will not take place. Hence as lift increases and more lift is obtained to control the fluid than other curves and curve approximately matches equal percentage curve.

13. CONCLUSION

It has been shown that the means of improving the conventional globe performance by adopting the new features like Non-Rotating stem, Integral seat, Guided disc etc. These new features are incorporated in the design to improve the performance parameters like valve sealing leakage rate, valve torque, packing emission requirements and minimized hand wheel effort. It has also been shown how FEA and CFD tools are used to effectively optimize the valve design. For instance, the body bonnet flange thickness optimization through design by code and design by FEA shows that the theoretical calculations results were very conservative compared to the FEA results. This approach leads to the significant weight reduction of the flange weight by *50%. Also FEA was done to validate the design by ensuring that the stress and strain levels are within the*

allowable limits. CFD analysis is performed to analyze the effect of shapes of plug and seat on the flow. From the analysis it is observed that for quick opening valve, trial 1 & trial 3 set can be used. For linear opening valve Trial 2 set can be used. For control valve, trial 3 set can be is proposed from which it seen that when lift varies from 4mm to 20mm, the discharge increases from 6.88m3/hr to 32.397m3/hr, hence it is concluded that the control of fluid obtained is approximately matches the equal percentage curve [Fig.1] as compared to Trial1, Trial 2 & Trial 3 set.

A tortuous path trim for a high-pressure turbine bypass valve was designed and installed to control velocity. CFD analysis was used to design the tortuous path and to study the flow field and performance of the valve installed inside the tortuous path trim. Using FEM, structural analysis was performed to check the structural stability of the trim disc .The valve performance was satisfactory with a maximum flow rate of 115 000 kg/h at the given operating conditions, which were an outlet pressure of 5 bar. ANSI class V leakage performance criteria were met .From the field test results, pressure let down was acceptable up to 91 bar with the designed trim.

A 2" Plexiglas globe valve model designed to permit visual observation and measurements of flow-induced force on the stem was built. An extensive test program was conducted with varying key parameters such as disc position and operating conditions. No dramatic increase of force from cavitation has been observed. Instead, it appeared to act as a force limiter at high disc opening by reducing the pressure drop seen from the disc.

The maximum transverse force was observed at intermediate opening (between 6 and 10mm) and it was calculated that it could reach 25% of the maximum axial force. Numerical predictions were in good agreement with experimental data and together with the analysis of experimental results supplied a better understanding of the flow-induced force on the stem.

Thermal shock effects on the BBBFJ behaviour of a valve used in nuclear industry were evaluated using numerical simulation. Choices were made about modelling that lead to the biggest "reasonable" calculation available in a standard engineering office, once CFD results are available. Modelling reveals several noticeable differences between thermo mechanical behaviour of the BBBFJ compared to a standard BFJ, attributed to design features and differences between thermal loadings.

All these reported differences will be validated or contradicted in further experimental work, which will allow iterative progress in the modelling part, and objective criticism of the modelling choices. Would the modelling happen to be good "on first shot", much work remains to do to numerically assess complex technological functions such as sealing of BFJ during transient loadings. Future work on this valve will focus on the evaluation of modelling results by comparison with experimental ones, and its possible use for other applications, like hard-facing thermal shock strength evaluation.

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4. TOP 10 SOLAR PLANTS IN THE WORLD

K.P.SHANKAR
DEPARTMENT OF MECHATRONICS (SECOND YEAR)

1. SOLAR STAR PROJECTS, CALIFORNIA, USA

Currently the largest solar power project in the world, two co-located plants in the Kern and Los Angeles counties in California make up the 579MW capacity Solar Star project. The plants generate enough electricity to power around 255,000 homes. Construction of the farms started in early 2013 and was completed in June 2015. The site is spread over 13 sq. km of land near Rosamond, California and it uses 1.7 million Sun Power made monocrystalline silicon modules on single-axis trackers.Solar Star is estimated to displace 570,000 tonnes of CO2 emissions annually, which is the equivalent of removing 108,000 cars from the road every year. The project uses Oasis Power Plant technology developed by Sun Power, which positions the panels to track the sun during daylight hours, to optimize energy capture by up to 25%. BHE Renewables owns the farms and sells the electricity to Southern California Edison under two long-term power purchase agreement.

2. DESERT SUNLIGHT SOLAR FARM, CALIFORNIA, USA

Operating a 550MW capacity, Desert Sunlight Solar Farm is located in the Riverside County in California and tied in second place with Topaz Solar Farm, which is in the Carrizo Plain region in the state. Ownership is shared between NextEra Energy Resources, GE Energy Financial Services, and Sumitomo Corporation of America. Energy produced at the farm serves 160,000 homes in the county, and avoids around 300,000 tonnes of CO2 per year, which is equal to taking around 60,000 cars off the road.

The project was constructed and is operated by First Solar, which also supplied the 8 million plus cadmium telluride solar modules that make up the farm. The site is built over 15.4sq km of land managed by the Federal Bureau of Land Management. Construction began in September 2011, with Phase I delivering 300MW capacity that is purchased by Pacific Gas and Electric Company, while Phase II, completed in 2015, has a capacity of 250MW, which is sold to Southern California Edison.

3. TOPAZ SOLAR FARMS, CALIFORNIA, USA

Topaz Solar Farms is a 550MW plant in San Luis Obispo County, California, that powers approximately 160,000 homes in the region. The $2.5 billion project was developed by First Solar but it was acquired by BHE Renewables in January 2012. Energy for the farm displaces approximately 377,000 tonnes of CO2 every year, equivalent to removing 73,000 cars from the road.

The project consists of nine million solar panels, which are mounted at a 25° angle for optimal sun exposure.

First Solar began construction of the plant in November 2011 and it was completed in 2014, covering 24.6sq km of land. Electricity from the project is sold to Pacific Gas and Electric Company under a 25-year power purchase agreement. The site is located next to the operational 230kV Morro Bay-to-Midway transmission line, which provides access to transmission capacity.

4. LONGYANGXIA DAM SOLAR PARK, QINGHAI, CHINA

Longyangxia Dam Solar Park is located at the Longyangxia Dam hydropower station on the Yellow River in Gonghe County in China's Qinghai province. The dam was commissioned in 1992. The solar project covers 9.16sq km of land and forms part of the one of the largest hybrid hydro-solar PV power stations in the world. Construction by China Power Investment began in March 2013 and was completed within nine months. In December 2013, the farm went online, with a 320MW capacity. Construction of phase II commenced in August 2014 and was completed in late 2015, raising the capacity to 530 MW. The addition of the solar park increased the hydropower plant's 1,280MW capacity. In phase II nine PV power generating segments will connect to the 330kV booster station that was built during Phase I. The plant is estimated to displace 795,000 tonnes of CO2 annually.

5. GOLMUD SOLAR PARK, QINGHAI, CHINA

Golmud Solar Park is a 500MW photovoltaic park located in the Qinghai Province, China. The site was built in 2009 and commissioned in October 2011. Phase-IV, which is currently under construction, will add another 60MW capacity to the site when completed.

6. COPPER MOUNTAIN SOLAR FACILITY, NEVADA CITY, CALIFORNIA, USA.

Located in Boulder City, Nevada, the Copper Mountain Solar Facility provides 458 MW of electricity serving around 18,000 homes annually. The farm uses nearly one million PV solar panels and covers 1.8sq km of land. The project is owned by Sempra US Gas and Power.

Phase I of the site was completed in December 2010, with the power generated sold to Pacific Gas and Electric. Pacific Gas and Electric also purchased electricity generated in phase II, while phase III was completed in early 2015 with the energy sold to Southern California Public Power Authority. The current capacity is set to increase to 552MW by the end of 2016, when the 94MW phase IV is completed.

7. CHARANKA SOLAR PARK, GUJURAT

Charanka Solar Park is a 345MW installation that forms part of the 600 MW Gujarat Solar Park in the North of India. The whole project is a collaboration between 21 companies. The farm is built within the 20.2sq km of desert land in the region. The park at Charanka, spread across 5,000 acres, has 500 MW of generation capacity of both solar and wind energy.

8. CESTAS SOLAR FARM, BORDEAUX, FRANCE.

Cestas Solar Farm in Bordeaux, France, is Europe's largest solar PV plant with a 300 MW capacity. The park, developed by Neoen, cost €360 million to build and it provides power for 300,000 homes.

Covering 2.5sq km, the project was constructed by Eiffage, Schneider Electric and Krinner and went online in October 2015. Solar modules were supplied hinese manufacturers, Trina Solar, Yingli Solar and Canadian Solar. The park was connected to France's high voltage network Réseau de transport d'électricité (RTE), which provides electricity across the country, in September 2015.

9. AGUA CALIENTE SOLAR, ARIZONA, USA.

The Agua Caliente Solar Project is a 290MW PV power plant located in the city of Yuma, Arizona. The park, which was designed, constructed and is operated by First Solar is jointly owned by NRG Energy and MidAmerican Solar. It was completed in April 2014 and powers 100,000 homes. The plant displaces 220,000 tonnes of CO2 annually, which is equal to equal to taking 40,000 cars off the road.

Agua Caliente can be controlled remotely from First Solar's operation centre. It uses also uses the company's grid integration and plant control system, which helps to maintain grid stability, as well as thin-film technology based CdTe PV panels from the developer. The project was awarded a $967 million loan from the Department of Energy.

10. CALIFORNIA VALLEY SOLAR RANCH (CVSR) IN SAN LUIS OBISPO, USA

California Valley Solar Ranch (CVSR) in San Luis Obispo County, California, has a 250MW capacity. Constructed by Sun Power, the plant was completed in October 2013 and is owned by NRG Energy and NRG Yield. CVSR generates enough power to serve approximately 100,000 homes in the county, and displaces 336,000 tonnes of greenhouse gas emissions.

The farm uses Sun Power's Oasis Power Plant Technology, which positions the panels to track the sun during daylight hours. Energy produced by the plant is sold to Pacific Gas and Electric.

5.PLC BASED WASTE WATER TREATMENT FOR AGRICULTURE

A.AROCKIA NITISH

ANAND RAJ

DEPARTMENT OF MECHANICAL (III YEAR)

A sewage treatment plant is quite necessary to receive the domestic and commercial waste and removes the materials which pose harm for general public. Its objective is to produce an environmentally-safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually as farm fertilizer) .Next objective is produce Greenhouse Gas(Methane) is important for electricity generation by burning it as a fuel in a Gas Turbine or Steam Generator. During the Rainy season the rain water collected from Large Pipe is diverted to a storage Tank.The storage tank has to be designed according to the water requirements, rainfall and catchment availability,Each drainage should have mesh filtere at mouth and first flush device followed by the filtration system before connecting to the storage tank.

Keywods: *PLC, Final Effluent, Aeration Tank,_Detritus Channels*

Introduction

A sewage treatment plant is quite necessary to receive the domestic and commercial waste and removes the materials which pose harm for general public. Expansion of urban populations and increased coverage of domestic water supply and sewerage give rise to greater quantities of municipal wastewater. Use of wastewater in agriculture could be an important consideration when its disposal is being planned in arid and semi-arid regions. Our objective is to produce an environmentally-safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually as farm fertilizer) .Next objective is produce

Greenhouse Gas(Methane) is important for electricity generation by burning it as a fuel in a Gas Turbine or Steam Generator. During the Rainy season the rain water collected from Large pipe is diverted to a storage tank. The storage tank has to be designed according to the water requirements, rainfall and catchment availability.

The specific objectives are :

- *Develop and calibrate for primary clarifiers .*
- *Develop a activated sludge process including the dynamics of nitrification and solid liquid separation.*
- *Develop the associated waste sludge treatment subsystem, anaerobic digestion, considering the new biological concepts of methanogenesis .*

Technology

PLC provides an automated control & monitoring system for the coarse screen and grit removal plant and controls in particular.

1. Detritus channels inlet and outlet penstocks

2. Coarse screens

3. Coarse screen conveyor

4. Travelling bridges (supervisory control only)

5. Grit classifiers

6. Supernatant pumps

Coarse Screen / Detritus Channels

- *The flow and velocity through each detritus channel and status of all penstocks upstream and downstream of the detritus channels are monitored and the PLC should automatically select the number of channels in service so as to maintain an acceptable pit velocity and equalize channel usage.*

Channel usage is changed (automatically or) manually via PLC in the following circumstances.

- *1. Inflow variations; taking into account the programmed maximum and minimum flows for each channel.*
- *2. Coarse screen failure – providing there is another suitable channel available to take the flow.*
- *3. Grit removal system failure – providing there is another channel available to take the flow.*
- *4. Manual Shutdown of the channel.*

Coarse Screen Conveyor

- *The coarse screen belt conveyor operates whenever a coarse screen is operating.*

When all the coarse screens have stopped operating the coarse screen conveyor continues to run for a timed period (1 minute) before it is stopped. The coarse screens continue to operate in the event of the coarse screens conveyor failure.

Travelling Bridges

- *The PLC in the detritus channel control room controls which channels are to be cleared of grit, these are any channels that are in service*
- ***The PLC operated the bridges as follows:***

  (i) High flow – continuous bridge operation.

  (ii) Moderate flow– fast intermittent bridge operation

  (iii) Low flow– slow intermittent operation.

Supernatant Pumping Station

- *The detritus PLC Monitor the supernatant wet well level and enables the pumps as follows:*

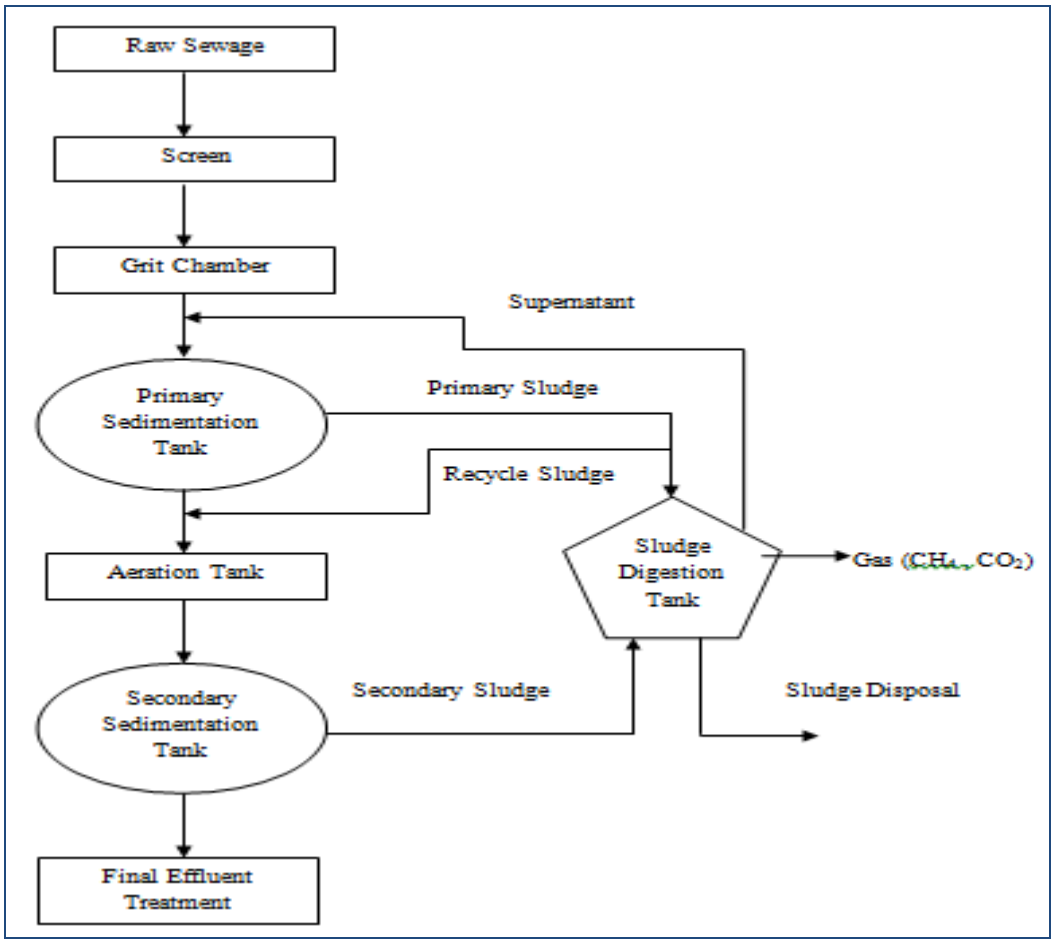
1. When the wet well level reaches High Level the duty pump is started.

2. When the wet well level reaches High High Level the assist pump is started.

3. When the wet well level reaches low level both the duty and assist pumps are stopped.

Fine Screens

- *The number of Fine Screens required to run is increased by one if any of the following occurs :*
  - *Inlet Channel high level, differential across the Fine Screens is high or the flow to full treatment is high.*
  - *At low flows the Fine Screens run in stepping mode to conserve energy and wear and tear.*



FLOWCHART

BUISINESS MODEL

- *The main objective of this investigation is to develop a least cost design procedure for wastewater treatment systems, which satisfy a set of specified constraints, and minimize life time costs.*
- *Life time cost includes capital, operation and maintenance costs. This work differs from the previous work in that the design and operation costs are considered in an integrated procedure.*

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"Nobody can take away what you've got in yourself
and everybody has potential they haven't used yet."

- Warren Buffett

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