Review on Redesigning Of Compact Hydraulic Tube Expansion System for Heat Exchanger

Prof. (Dr.) Vilas B. Shinde1, Javed Kazi2

ABSTRACT

Hydraulic tube expansion power units are main driving components of driving system. Consisting mainly a motor, a reservoir and a hydraulic pump these units can generate a tremendous amount of power to drive any kind of hydraulic ram. Hydraulic power units are based on Pascal's law of physics drawing their power from ratios of area and pressure. Heating of hydraulic oil in operation is caused by inefficiencies. Inefficiencies result in losses of input power, which are converted to heat.. In this work an attempt is made to reduce the unwanted weight of power pack, buy studying different part of hydraulic tube expansion system unit & how we can reduce the weight of hydraulic tube expansion unit.

Keywords: DC valve, electric motor, gear pump, hydraulic motor, oil tank

I. INTRODUCTION

A hydraulic system employs enclosed fluid to transfer energy from one source to another, and subsequently create rotary motion, linear motion, or force. Hydraulic power units apply the pressure that drives motors, cylinders, and other complementary parts of a hydraulic system. Unlike standard pumps, these power units use multi-stage pressurization networks to move fluid, and they often incorporate temperature control devices. The mechanical characteristics and specifications of a hydraulic power unit dictate the type of projects for which it can be effective.

Some of the important factors that influence a hydraulic power unit"s performance are pressure limits, power capacity, and reservoir volume. In addition, its physical characteristics, including size, power supply, and pumping strength are also significant considerations. To better understand the operating principles and design features in a hydraulic power unit, it may be helpful to look at the basic components of a standard model used in industrial hydraulic systems. As the temperature of hydraulic oil increases, input power falls – and if the total loss of power is greater than the heat dissipated, the hydraulic system will eventually overheat. And if oil overheats, it loses its lubricating properties and increases friction and wear on hydraulic components, meaning hardened seals and increased wear to the system. Another problem caused by high oil temperatures is reduced oil viscosity – which often leads to oil leakages. Because hydraulic components are constructed with very close tolerances, high heat and lubrication loss can also cause severe damage or seizure.

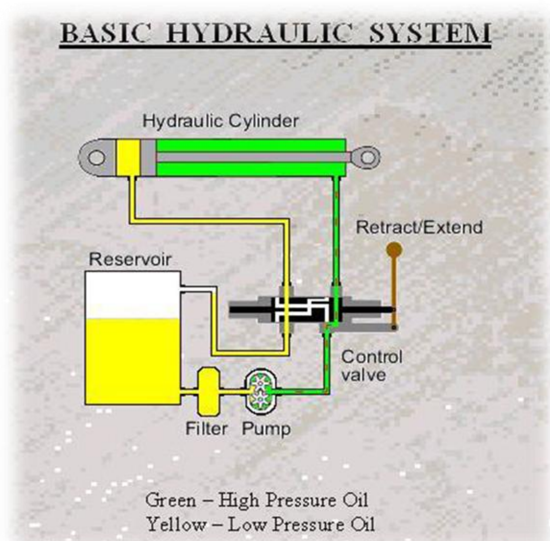

Fig.1 (source: *International Journal of Computational Engineering Research*)

ISSN: 2278 – 7798

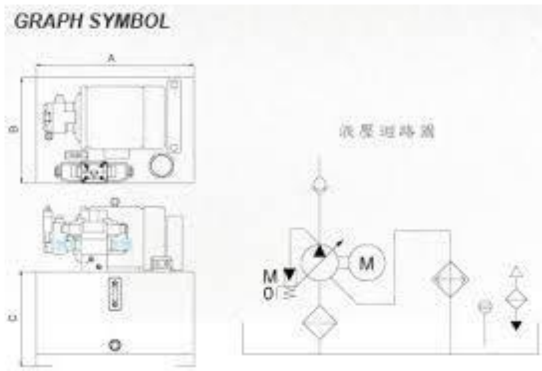

Fig.2(source: *International Journal of Computational Engineering Research*)

Repairs can be costly and at worst, operations may have to close down. In many casesit is possible to do without cooling of the power unit because due to the reducedenergy consumption the hydraulic fluid will not heat up excessively. This in turn allows a compacter design which reduces complexity and acquisition costs

II. LITERATURE SURVEY

D.L.Aldred et. al. (2010) [1] has mentioned about Hydraulic expansion of tube to tube sheet joints offers considerable benefits over conventional roller expansion. Equipment is available to produce such joints in normal, commercial applications. Theories are available to predict joint strength and tightness, but they do not allow for the many variables met in production. Practical testing is recommended to establish expansion pressures and the system enables hydraulic leak testing to be carried out on sample expansions. The use of optimum groove geometry is recommended to achieve the physics drawing their power from ratios of area and pressure. Heating of hydraulic oil in operation is caused by inefficiencies. Inefficiencies result in losses of input power, which are converted toheat. If the total input power lost to heat is greater than the heat dissipated, the hydraulic system will eventually overheat. In this work an attempt is made to reduce the unwanted temperature of oil by changing the construction and material of the tankand providing fins over it. Finally the improvement of efficiency of power pack by reducing heat losses has been studied and analyzed.

M.L.R.Chaitanya Lahari & DR. B. SRINI VASA REDDY(2014)[2] in his paper “Enhancement of the Performance of Hydraulic Power Pack by Increasing Heat Dissipation” has elaborated Hydraulic power units are main driving components of driving system. Consisting mainly a motor, a reservoir and a hydraulic pump these units can generate a tremendous amount of power to drive any kind of hydraulic ram. Hydraulic power units are based on Pascal's law of physics drawing their power from ratios of area and pressure. Heating of hydraulic oil in operation is caused by inefficiencies. Inefficiencies result in losses of input power, which are converted to heat. If the total input power lost to heat is greater than the heat dissipated, the hydraulic system will eventually overheat. In this work an attempt is made to reduce the unwanted temperature of oil by changing the construction and material of the tank and providing fins over it. Finally the improvement of efficiency of power pack by reducing heat losses has been studied and analyzed.

M. Rama Narasimha Reddy et.al.(2014)[3] in his paper entitle “ Design of Hydraulic Power Pack for Vertical Turret Lathe” has explain the Design of hydraulic power pack for vertical turret lathe. This Hydraulic power pack is used to obtain the various motions of the Vertical Turret Lathe Clamping and unclamping is also done with hydraulic system. Hence versatility and reliability of hydraulics is prime importance. The power pack is an integral supply unit usually containing a pump, reservoir, relief valve and direction control valve, Pressure control valve. For the purpose of design of hydraulic power pack, the component are to be designed are pump, reservoir, heat exchanger and an electric motor. Hydraulic drives and controls have become more important due to automation and mechanization. Many of the modern and powerful machinery are controlled partly or completely by hydraulics. Hydraulic system is less complicated and has less moving parts.

ISSN: 2278 – 7798

Today drive and control system engineering is inconceivable without hydraulics. Special emphasis is made on design of power pack in which the elements, maintenance aspects and trouble-shooting methods is dealt with.

Tic.v & Lovrec (2012)[4] in there paper "DESIGN OF MODERNHYDRAULIC TANK USING FLUID FLOW SIMULATION" has explain that hydraulic power units are one of the most commonly used power source in industry. The progress in resent year has offered high efficiency and reliable hydraulic components , yet the hydraulic tank design is often neglected part of development. The paper presents the development of industrial 400 litre hydraulic tank. In order to reduce oil swirling and improve stability of fluid flow, CFD simulation of oil flow inside hydraulic tank were made. Several variation of new hydraulic tank design is compared with standard industrial tank. Furthe rmore to achieve steady flow throw the entire reservoir and reduce the phenomena of oil swirling.

Amey Shirodkar and sangita Bansode (2014)[5] in " Optimization of Tube sheet Thickness of Shell and Tube Heat Exchanger" has explain heat exchanger is a device built for efficient heat transfer from one medium to another. Many a times some issues occurred in the heat exchanger. Out of which this paper is concerned with the thermo-mechanical issue that is ther mal expansion of tube sheet due to high temperature. It is necessary to make a optimize design which is safe, economical and accurate. Due to high temperature and high pressure fluids tube sheet of heat exchanger expands which results expansion of shell which causes deformation of heat exchanger. To avoid this deformation, analysis of effect of temperature variation and associated stresses in the tube sheet is necessary. Objective of this paper is to analyse the temperature variation at the junction of shell to tube sheet junction in shell and tube heat exchanger and optimization of tube sheet thickness.

Shravan H. Gawande et.al.(2012)[6] " Design and Development of Shell & Tube Heat Exchanger for Beverage" has explain a simplified approach to design a Shell & Tube Heat Exchanger [STHE] for beverage and process industry application is presented. The design of STHE includes thermal design and mechanical design. The thermal design of STHE involves evaluation of required effective surface area (i.e. number of tubes) and finding out log mean temperature difference [LMTD]. Whereas, the mechanical design includes the design of main shell under internal & external pressure, tube design, baffles design gasket, etc. The design was carried out by referring ASME/TEMA standards, available at the company. The complete design, fabrication, testing and analysis work was carried out at Alfa Laval (India), Ltd., Pune-12. In the second part of this paper detail view of design optimization is presented by flow induced vibration analysis [FVA].

A.Karrech, A.Seibi (2010) [7] have elaborated a comprehensive coverage of the expansion of metallic tubes subjected to large radial and circumferential plastic deformations. This process can be achieved by driving rigid conical mandrels of various diameters through them either mechanically or hydraulically in order to obtain desirable expansion ratios. A mathematical model was developed to predict the stress field in the expanded zone, the drawing force required for expansion, and the resulting dissipated energy from which optimum mandrel shapes were obtained. A finite element analysis was used to validate the theoretical results. A good agreement was obtained in terms of drawing force and dissipated energy for different geometric constraints and friction coefficients. The study showed that the optimum mandrel angle ranges between 22 and 25 degrees for low friction and increases non-linearly
when friction increases.

M.Podhorsky et. al. (2007) [8] have discussed in their paper entitled "design of modern heat exchangers using hydraulic tube expansion" In this contribution the theory of the hydraulic tube securing process HYTEX, the quality features as well as the construction of thick and thin tube sheet waste heat boilers for high pressure and temperature loads using the advantage of the Strain-Blocking-System (SBS) will be discussed. Also the Multi-stage heat exchangers will be introduced

Ding Tang, Dayong Li, Yinghong Peng (2004) [9] have discussed in their paper entitled "Optimization to the tube–fin contact status of the tube expansion process". This paper

ISSN: 2278 – 7798

describes The tube–fin contact status is an important factor influencing both thermal resistance and service life of the tube–fin heat exchanger. Tube expansion process brings forming defects of gaps at the tube–fin interfaces. And elimination of this forming defect is proved to be difficult. This paper presents a novel method in improving the tube–fin contact status of heat exchanger. From simulation results, distribution of the contact pressure along the tube–fin interface can be obtained. Then, an optimization process integrated with FE simulation is established for the sectional profile of the fin collar. The fin collar is represented with spine curves. Results show that after the optimization, the gap at the tube–fin interfaces is basically eliminated and the tube–fin contact status is significantly improved. Furthermore, flanging process for the optimized sectional shape of the fin collar is discussed

H.G. Dashti et al. (2011) [10] has reported in their paper entitled “Evaluation of tube to collector connection by hydraulic expansion method in PGV-1000 steam generators” about a Investigations on steam generators failure due to cracking in collector ligaments at perforated parts determined that connection process of the tubes to collector could be one of the main breakdown causes. The stability and strength of tube to collector joint is dependent to the geometry of tube and collector, the joining process and the operational conditions. In this research hydraulic expansion method has been considered as connection method of tube to collector. The Finite Element Method (FEM) was used to simulate the hydraulic expansion process and determine stress condition of the joints. The contact stresses between the tube and collector interface were modeled using contact elements of ANSYS program. Furthermore, the effect of clearance between tube and collector on the residual stresses around of joints was investigated. Some specimens from collector and tube materials were tested at various temperatures and their results were used at rate-independent multi-linear Mises plasticity model for FE analysis. Required connection strength between tube and collector is estimated based on ASME rules and compared with FE results. The results show that the residual tensile stresses could be greatly increased by decreasing of initial clearance. The highest value of residual stresses was observed around of collector holes nevertheless it was considerably lesser than obtained residual stresses in explosive method. The contact pressure and other parameters were in allowable ranges and the friction stresses were negligible.

Ying-Ting Shen et. al. (2012) [11] have presented a simple practical method in their paper entitled “Redesign for product innovation”, In today’s market, most companies redesign to create new products. Redesign improves product quality and reduces cycle time. However, most techniques limit innovation. They modify a single reference product, which closely matches user needs, and only introduce new products when major conflicts exist between user needs and existing products. This study introduces a new redesign for product innovation approach. The approach combines two or more distinct reference designs into a single new product. The process creates design conflicts. The induced conflicts stimulate innovation. At the same time, the approach uses structured redesign techniques and structured design principles to overcome the conflicts, which improves solution quality and reduces cycle time. The study also presents a case study to demonstrate the approach

Andrew Tobias (2003) [12] have demonstrated in their work “O.R. techniques for use in redesigning manufacturing and associated business systems” about a In the present industrial climate of change, radical redesigning of manufacturing systems has
now become well established. The present paper introduces a selection of numerical and analytical techniques for project work in this area. These are directed towards project planning, business/sales analysis, manufacturing systems analysis, simulating
the operation of a manufacturing system with proposed changes, the streamlining of business systems, and also bottom-up product costing. Manufacturing systems engineering is a massive O.R. application are enjoying significant growth.

Michale Dubravcik, Stefan Kender (2012) [13] in their paper entitled “Application of reverse engineering techniques in mechanics system”. In today’s industry and production systems it´s important to do mechanics or measurements systems services regularly. In case of damages it is required to eliminate these in shortest time period, to avoid time losses and obviously also financial losses. In case

ISSN: 2278 – 7798

of destructive failure of devices, or their parts it is required to change them for new one. However, nowadays we know various types of techniques which are available for substitution of damaged parts in very short time period. One section of these techniques is reverse engineering. Especially techniques like 3D scanning and rapid prototyping. Submitted article analyse reverse engineering techniques utilizable for mechanics or measurements system services.

III. PROBLEM DEFINITION

Currently the hydraulic expansion machine use by the idented company is using is use to expand tube size range 5/8” to 4” . But in most of heat exchanger tube size range from ½” to 2” so these customers has to buy same machine and the weight of machine is also very high it is about 120kg. The cost of the machine is also high and it is three phase machine. As three phase is not readily available every were in industry. Therefore it is necessary to develop and redesign the compact hydraulic expansion system

It also consider the problem of oil leakage & temperature increase, therefore the control system is necessary to design to solve the problem

IV. METHODOLOGY

This section explains the detailed methodology adopted to redesigning of compact hydraulic expansion system

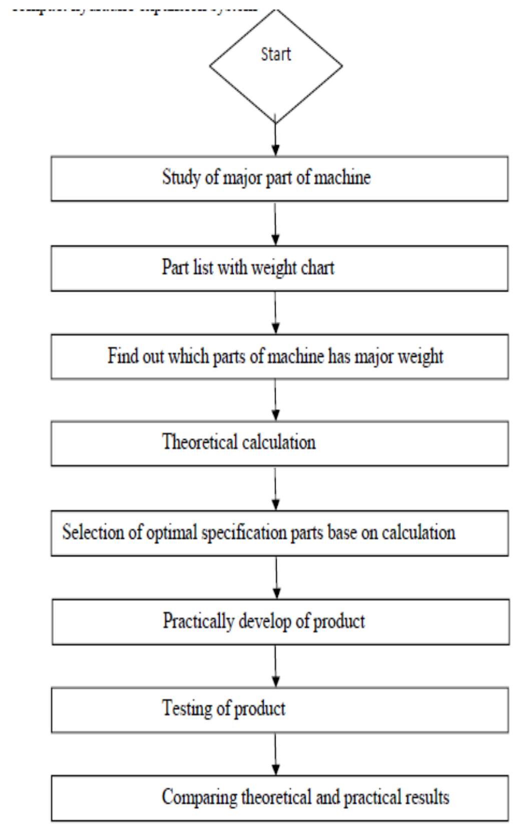

FIG 1: METHODOLOGY CHART

❖ Study of major parts of machine

Major parts are as follow

☐ Electric motor (3.7 KW 5 HP 1440 RPM secimens Electric motor)

☐ Hydraulic gear pump (23 lpm gear pump)

☐ 4/2 way DC valve

☐ Oil tank (45L capacity)

☐ Hydraulic motor

❖ Part list and weight chart

Part	Weight of part in kg
Electrical motor	39
Hydraulic gear pump	7

ISSN: 2278 – 7798

Oil tank	46
Manifold	9
DC valve	7
QRC	1
Hydraulic Motor	11
Pressure gauge	.2
Total	120

- ❖ Find out which parts of machine has major weight, and where we can work on toreduce weight of machine
- Manifold: it is made of ms so its weight is 9kg can be converted to aluminium
- and also its size can be reduce to reduce weight. Weight can be reduce to
- aaproxmately 8kg
- Electric motor : is 5 hp motor if we use 2 of 3 hp motor if possible can be
- reduce
- Oil tank: thickness of oil tank sheet is about 4mm and its capacity is 50liter, if
- we reduce the thickness to 1.5mm and capacity to 20-25 litre

- ❖ Theoretical formula and calculation
- Electric motor (kw)= pressure x flow/600
- Hydraulic motor speed (rpm) = gear pump flow rate (LPM) x
- 1000/displacement
- Torque = pressure x displacement (cc)/ 2 x 3.14

- ❖ Selection of optimal specification parts base on calculation

Kw	lpm	bar	cc	rpm	(N\mm)
3.7	23	96.5	380	61	5759
2.2	16	82.5	380	42	4922
2.2	23	57.3	380	61	3424
1.5	16	56.25	380	42	3356
1.5	23	39.13	380	61	2334

The optimal parts we select is highlighted in above table

V. EXPECTED OUTCOME

The expected outcome of this project is to successfully redesigning and develop compact hydraulic tube expansion system , which will expand tube size range from ½" to 2". And theoretical results are approximately same as practical results.

REFERENCES

[1] D.L. Aldred," Hydraulic Expansion of Tube to Tube Sheet Joints"sciencedirect, 2010

[2] M.L.R.Chaitanya Lahari & DR.B.SRINIVASA REDDY, "Enhancement of the Performance of Hydraulic Power Pack by Increasing Heat Dissipation" International Journal of Computational Engineering Research (IJCER), (2014)

[3] M. Rama Narasiimha Reddy, "Design of Hydraulic Power Pack for Vertical Turret Lathe" International Journal of Research in Mechanical Engineering, 2014

[4] Tic.v & Lovrec "DESIGN OF MODERN HYDRAULIC TANK USING FLUID FLOW SIMULATION" International Journal of Research in Mechanical Engineering, 2014

[5] Amey Shirodkar and Sangita Bansode, in " Optimization of Tube sheet Thickness of

ISSN: 2278 – 7798

Shell and Tube Heat Exchanger" IJISET - International Journal of Innovative Science, Engineering & Technology, 2014

[6] Shravan H. Gawande, " Design and Development of Shell & Tube Heat Exchanger for Beverage" modern mechanical engineering, 2012

[7] A. Karrech, A. Seibi, "Analytical model for the expansion of tubes under tension", Journal of Materials Processing Technology, Volume 210, Issue 2, 19 January 2010

[8] M. Podhorsky,"DESIGN OF MODERN HEAT EXCHANGERS USING HYDRAULIC TUBE EXPANSION", science direct, 2007.

[9] Ding Tang, Dayong Li, Yinghong Peng, "Optimization to the tube–fin contact status of the tube expansion process", science direct, 2004.

[10] H.G. Dashti, B. Hashemi, S.A. Jahromi, "Evaluation of tube to collector connection by hydraulic expansion method in PGV-1000 steam generators".

[11] Ying-Ting Shen"Redesign for product innovation", sacience direct , 2004.

[12] Andrew Tobias. "O.R. techniques for use in redesigning manufacturing and associated business systems", European Journal of Operational Research,2003.

[13] Michale Dubravcik, Stefan Kender ,"Application of reverse engineering techniques in mechanics system". ScienceDirect,2012

[14] Rita Kukafka, Jessica S. Ancker, Connie Chan, John Chelico, Sharib Khan, Selasie Mortoti. "Redesigning electronic health record systems to support public health".ScienceDirect,2007.

[15] Matej Paulic, Tomaz Irgolic, Joze Balic, Franc Cus, Andrej Cupar, Tomaz Brajlih, Igor Drstvensek. "Reverse Engineering of Parts with Optical Scanning and AdditiveManufacturings". ScienceDirect,2014.

ISSN: 2278 – 7798