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Hydraulic Jack operated Hose Crimping Machine

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***Abstract*- The present paper deals with developing of a crimping machine that can crimp hydraulic hoses with its fitting without the use of electricity. Detailed literature review indicates the fabrication of crimping machine that operates with electricity that inspired the authors to develop a hydraulic crimping machine that works without electrical power. Such a crimping machine is very useful when the rig is in movement and suitable for emergency crimping work in order to avoid shutdown time. The author has used Autodesk inventor software for designing critical components of the machine and obtained safety factor more than one for all the critical components. Safety factor less than one leads to the unsafe working condition of the critical parts. Fabrication of the whole assembly has been completed successfully for the required crimping for a hose size of 19.05 mm. The crimping machine has been tested successfully for crimping the required hose size. The design of the machine can be altered so that it can accommodate different die sizes in order to crimp hoses of different sizes**

Keywords: **Crimping machine, hydraulic jack, crimping plate, safety factor, electric crimping machine.**

I. INTRODUCTION

Crimping technology is a way of connecting hydraulic hoses to its fitting. Crimping machine is a hose assembly equipment which is operated with the help of hydraulic oil, electricity or a combination between electricity and hydraulic oil. Hydraulic hose crimping machine is used to crimp hydraulic hoses with different hose sizes and different shapes of fitting as well as different fitting sizes. Hydraulic power is used for crimpers because it gives high crimping pressure which can be used for very high pressure applications. Currently crimping is used in nearly all the hoses. In fact, crimping has become very important technology because of the high pressure which is used in the modern equipment.

1.1 Hydraulic and Electric Crimping Machine

Parker Company has many types of crimping machines which crimp the hydraulic hoses. For example, the crimping machine with model 83C-001 is shown in the figure 1below. It crimps the hoses with the use of hydraulic pressure from the oil and the required pressure is obtained from the pump which is operated by electric motor. The working principle of this machine is as follows. First of all, we should mark the insertion depth of the hose and we should also push the fitting into the hose until the marked point. Second step is to move the pusher of the crimping machine in the full up position by lifting the back half of the split die ring. It is locked in the up position by pushing the slide pin 'in' to make sure that it will not fall on in the technician's hand while fixing the die. Then we have to lubricate the die bowl using a premium quality lithium based grease and place the die into the adapter bowl to crimp the required hose. We have to select the correct die with the die ring based on the size. After that, place the spacer ring on locating step of the adapter bowl if required. Next, lower the back half of the split die ring by pulling the slide pin and insert the front half of the split die ring. After that position the hose with its fitting from below and rest the bottom of the coupling on die step to make sure it will not get pressed more from the die step. If hose is over pressed then the hose can't do the required job. Finally, we have to start the machine and crimp the hose to get it crimped.

(Courtesy: ProQuest Science Journal)
Figure1 Electric crimping machine (Model:4400)

The present work is about hose crimping machine which works without electricity but works with hydraulic pressure only with the help of hydraulic jack. This crimping machine will be helpful for drilling companies especially while the rig is in movement because there will be no electricity during movement of the rig from one place to another. Advantage of the system is that it can be carried easily from one place to another because of its low weight and small size. The main parts of this machine are die and the hydraulic jack. It can crimp different hose sizes. The only thing which should be considered is that the chosen die size must be suitable for the required hose. To crimp a hydraulic hose in this machine we have to choose the correct size of the die. To crimp a hose in this machine, the insertion depth of the hose should be marked and the fitting should also be pushed into the hose until the marked point. After that we have to enter the hose assembly in the machine and crimp it. This machine can be used in many companies because of the advantages of this system such as low cost, high pressure, small size and can work without electricity.

II. LITERATURE REVIEW

Hose crimping is a forming without noise, without environment risk and the operation is quick. Finland based Lillbacka Company manufactures verities of crimping machines for varies operations. Side feed machine (crimper) is hydraulic operated by means of an electrically operated pump (Hitchcox and Alan, 2003) that can produce 830 tons of crimping force and crimping diameters of over 10 inches. Control systems are selected based on the type of service of the machine.

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Hydraulic crimping machine that has 20-gal hydraulic power unit that occupy very little floor space (Schneider and Richard, 1997) has 6 jaws that moves radially at the same rate of level that ensure leak proof crimp. This crimping machine is electrically operated by 5 hp motor that drives a 7 ¼ -g pm pump that can generate 6 ¼ tons of force. Crimping assembly can be easily removed because of an open throat at the top of the crimping head.

Flexible hose lines ease routing, absorb vibration and adjust to connected component's movements. The crimping is done manually (Higgins and Amy, 2000) with the following steps,

1. Required length of the hose is made and two clips are put on the hose end. The nipple is lubricated and inserted on the hose.
2. Hose is inserted on the king nipple and clips are inserted on the hose.
3. Tighten the clips using pliers.

This system cannot be used for high pressure applications as the hose material cannot withstand high pressure.

The crimping operation using a polyurethane tool and a hydraulic pressure to assemble tubular components has been evaluated with the help of finite element method and its application (Shirgaokar, Ngaile, Altan, Yu, Balconi, Rentfrow, and Worrell, 2003). The goal of this method was to improve the performance of the assembly by material properties of the tube. While crimping of the double grooved rod with the tolerance casing will be easy to determine the effect of the manufacturing and the misalignment between the rod and the casing on the quality of the finished assembly.

Engineering designs can be defined as that stage of the product development process through which the designer makes a specification of the product to be designed in addition to that he generates many solutions for that product. Solid modeling and 3D computer aided design has become a critical element in the product development processes to be found in the industries (Holand, Ocallaghan and Osullivan, 2003). This research presents the constrain of computer aided design technology to support the beginner designers in their first stage. The technology has been developed tin terms of the applications for Autodesk inventor and the 3D solid modeling environment.

In the conclusion of the literature review we can see that all the studies have a great ideas about how to crimp the different types of hoses and these were useful ideas which have been helped the author to do the present work.

III. Drawing of Critical Components using Auto Desk

Inventor software

Auto Desk Inventor software is used to complete the design drawing of the critical parts of the hose crimping machine such as crimping plate, pressure plate, crimping ring, travelling bar and Jack's base plate. The design drawings of the crimping plate is shown in figure below.

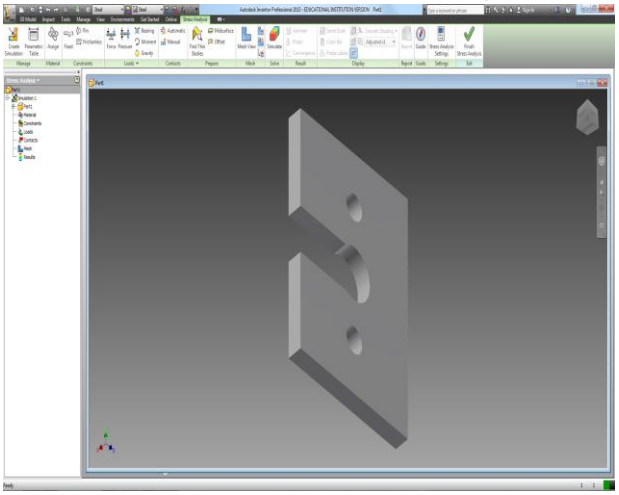

Figure 2 Full design of crimping plate

IV. Results and Discussions

The Critical parts strength has to be tested for safe working of the machine. The safety factor is a very important criterion to ascertain safe working of each part as well as the whole assembly. It is evident from the results of the table shown below that the factor of safety is more than one that justify the dimensions chosen can be accepted.

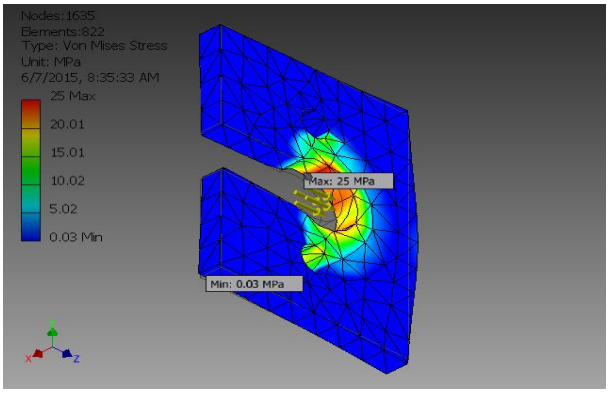

Figure 3 Stress in the Crimping Plate from Auto desk inventor software

The design diagram as an output from the Autodesk inventor for the crimping plate is shown in the above figure. The lift color code bar shows the grade of the colors. The blue color in the code bar shows the lower stressed whereas the red zone indicates maximum stress levels. The safety factor is 8.27 that justify that the specification selected is safe for the given pressure. The Physical properties and material properties are shown in Table 1 and 2 respectively.

TABLE 1 PHYSICAL PROPERTIES OF THE CRIMPING PLATE

Material	Steel
Density	7.85 g/cm^3
Mass	5.53935 kg
Area	95142.6 mm^2
Volume	705650 mm^3
Center of Gravity	x=9.9 mm, y=0.0636966 mm z=4.68082 mm

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TABLE 2 MATERIAL PROPERTIES OF THE CRIMPING PLATE

⊟ Name	Steel	
General	Mass Density	7.85 g/cm^3
	Yield Strength	207 MPa
	Ultimate Tensile Strength	345 MPa
Stress	Young's Modulus	210 GPa
	Poisson's Ratio	0.3 ul
	Shear Modulus	80.7692 GPa
Stress Thermal	Expansion Coefficient	0.000012 ul/c
	Thermal Conductivity	56 W/(m K)
	Specific Heat	460 J/(kg c)
Part Name(s)	Part1	

The summary of the results for the crimping plate is shown in Table 3 below.

TABLE 3 RESULT SUMMARY FOR THE CRIMPING PLATE

Name	Minimum	Maximum
Volume	705657 mm^3	
Mass	5.53941 kg	
Von Mises Stress	0.0292048 MPa	25.0016 MPa
1st Principal Stress	-1.93056 MPa	15.8189 MPa
3rd Principal Stress	-19.4131 MPa	2.03337 MPa
Displacement	0 mm	0.00367825 mm
Safety Factor	8.27947 ul	15 ul
Stress XX	-4.74541 MPa	2.59708 MPa
Stress XY	-1.90916 MPa	1.8214 MPa
Stress XZ	-1.24119 MPa	1.22506 MPa
Stress YY	-13.8623 MPa	13.1714 MPa
Stress YZ	-12.4133 MPa	11.9789 MPa
Stress ZZ	-13.2326 MPa	14.9266 MPa

The above result summary shows the results of the crimping plate and the most important thing have been shown in the above table is the safety factor of the crimping plate. As we can see that the safety factor of the crimping plate is 8.27. So, we can understand that, the crimping plate will withstand for the given pressure without failure.

The fabrication of the machine is completed as per the design drawings and the completed assembly is shown in Figure 4. Testing of the machine is very important to confirm that the machine works satisfactorily as per the requirement. The crimping machine is tested at Hydroline company that has the required facilities. The machine was tested for crimping a hose diameter of 19.05mm at a pressure of 137 bar. The crimping has been done satisfactorily without any failure.

Figure 4 Final assembly of the crimping machine

V. CONCLUSIONS AND FUTURE WORK

Conclusions

Developing of hydraulic operated hose crimping machine that can be operated without electricity is the aim of the present work that resulted from the need of crimping hoses when the rig is in movement where it is not possible to access electrical power for emergency crimping operation. The previous literature confines crimping machines that needs electrical power for its operation. The following are the important conclusions.

1. Assembly drawing of the machine is completed in AUTOCAD.
2. Design of the critical parts have been accomplished using AUTODESK INVENTOR software and the safety factor for the critical parts obtained more than one that ensures the safe operation of the machine.
3. Fabrication of the entire crimping machine has been successfully carried out.
4. Testing of the crimping machine has been successfully carried out for crimping of hose of size (diameter of 19.05 mm) at a pressure of 137 bar at Hydroline company where adequate facilities are available.

Future work

For the future improvement of the crimping machine, we have to replace the hydraulic jack with a higher capacity jack to crimp bigger sizes of hydraulic hoses. In addition, we should use different sizes of dies for the crimping machine to crimp different hose sizes. We also need to modify the size of crimping machine to accommodate bigger hose sizes.

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