

# Design Automation Nozzle Reinforcement Analysis for Pressure Vessel

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**Abstract** — Reactor is a device or process in which chemical reactions take place during a chemical conversion type of process. Reactor has many parts in their structures such as nozzles, supports, shell and head etc. All nozzles on shell and head is been design based on ASME SECTION VIII DIV 2. In industries reactor generation required more time in designing and to calculated weight of nozzle for estimation purpose. By using automation program macro 4 to 5 days work has been completed in 3 to 4 hour. Same type of reactor parts model drawing to parametric relation, new manufacturing drawing of reactor nozzle will automatically produced. In this paper, drawing automation of reactor nozzle is carried out using Solid Edge.

**Keywords** — pressure vessel, Drawing automation, visual basic programming, ASME.

## I. INTRODUCTION

A pressure vessel is a closed container designed to hold gases or liquids at a pressure substantially different from the ambient pressure. The primary purpose of pressure vessel is to separate two or more areas of different pressures. Pressure vessels of varied construction are used for handling and storage of liquids or gases.

Pressure vessels are used in a variety of applications in industry and the private sector. They appear in these sectors as industrial compressed air receivers and domestic hot water storage tanks. Pressure vessels are diving cylinder, recompression chamber, distillation towers, autoclaves and many other vessels in mining or oil refineries and petrochemical plants, nuclear reactor vessel, pneumatic reservoir, hydraulic reservoir under pressure and storage vessels for liquefied gases such as ammonia, chlorine, propane, butane and LPG various parts like top head, bottom head, shell and nozzles etc. Various parts and locations of nozzles in the vessel are shown in Figure 1.

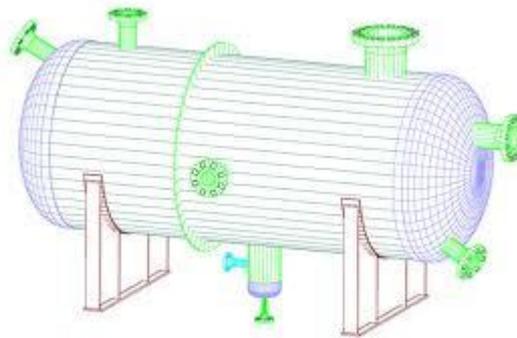


Fig1. Nozzle at different location on vessel

Purpose of Automation program for nozzles is to estimation of nozzle weight for Div 2 equipment. Second purpose is to create procurement drawings by linking up program with solid edge software and for Save time. But there is limitation of Program also and that is, it cannot consider multiple opening in shell or head with overlapping reinforcement limit and in this case designer has to do design of nozzle. Other limitations are, Design of offset nozzle on head /shell is not consider in program for that separate design has to be done by designer, Angular nozzle automation drawing not done in program. Only weight and designing of angular nozzle is been consider in program and In case of nozzle loads higher than standard nozzle loads, design engineer need to check the flanges.

### A. Nozzle Automation program

After entering the specific input in input form of macro, design calculation of nozzle has been carried out in visual basic program. Designed data of nozzle is been developed and optimized designed data has been is taken for generating drawing in solid edge software and drawing is get created. At last it may display the weight of nozzles in drawing itself. So by using this automation macro program, estimation team may save lot of time to calculate the weight of nozzle at time of enquiry.

Reactor various parts like top head, bottom head, shell and nozzles etc. Various parts and locations of nozzles in the vessel are shown in Figure 1. In industries the manufacturing drawing was prepared using AutoCAD as a drafting tool. There was a lot of time consuming in editing, revising the drawing such a fabrication drawing in AutoCAD. Thus, it is needed to automate the manufacturing drawing of nozzle reactor.

### B. Material

The range of materials used for Pressure Vessels, Nozzles and Flanges are as follow:

- Carbon steel with less than 0.30 carbons.
- Carbon manganese steel (giving higher strength than carbon steel)
- Low alloy steels
- High alloy steels
- Austenitic stainless steel

## II. LITERATURE REVIEW

Lin, B. T. and Hsu, S. H. [1] have described an automated design system for drawing dies using CAD software. Taking advantages of pre-built design knowledge base and data base, this system is able to output designs of the main components of a drawing, such as upper dies, lower dies and blank holders, upon users input of design information of blank lines, punch open lines, press data, and types of subcomponents such as hooks, guides, and stopper seats. This die design system is built on top of CATIA V5, and makes use of its built in modules, including part design, automation and scripting and knowledge advisor.

Chavali .S.R and Sen C. and Mocko G. M and Summers J. D. [2] have discussed the development and usage of rule based design (RBD) in an industrial engineer-to order (ETO) application is presented. First, three different design and geometric modelling processes are discussed for specifying customized bottle packaging systems, assemblies, and components. These processes include: (1) a manual method in which custom design specifications are uniquely created using two-dimension CAD software, (2) a custom in-house Visual Basic automated system built on a commercially available three-dimension solid modelling package, and (3) a commercially available rule based system integrated with a commercially available three-dimensional solid modeling software tool. The advantages and limitations of the different modelling approaches are presented and evaluated qualitatively.

Avinash and Kulkarni [1] have discussed current developments in the determination of stress concentration factor in pressure vessels at openings. The motivation for this research is to analyse the stress concentration occurring at the openings of the pressure vessels and the means to reduce the effect of the same. Most of the researchers have worked on the stress concentration occurring at circular and radial openings in the shell under internal pressure. Also some of the researchers have worked on holes in the end covers. In this paper the recent developments, theories for estimation of stress concentration are presented and the scope for future studies is also presented.

Bosnia and Herzegovina [2] has discussed comparison of design method For opening in cylindrical shells under internal pressure reinforced by set on Nozzle from this it is observed ASME that design method mostly gives the smallest values of permissible design pressure, which shows that this method provides the greatest design safety but requires the largest amount of reinforcement material. At the opposite, PD 5500 design method mostly gives the greatest values, thus requiring the smallest amount of reinforcement material but providing the least safety. The calculation procedures used in the three methods are significantly different, so the comparison has been based on the maximum permissible design pressures for 45 specific geometries calculated using the three methods.

## III. IMPLEMENTATION

### A. Development of macro forms for nozzle design:

After entering the specific input in input form of macro, design calculation of nozzle has been carried out in visual basic program. Designed data of nozzle is been developed and optimized designed data has been is taken for generating drawing in solid edge software and drawing is get created. To start a program, open 2.24 forg calc Div 2(version 0).xls, then home screen of program excel sheet is open and click enable macro, click on open new project. Macro home screen is shown in fig 2, and selection of nozzle has to be done , its figure shown in fig 3.



Output of nozzle, in its is gives all design data as output of nozzle and weight of nozzle itself in output sheet nozzle.

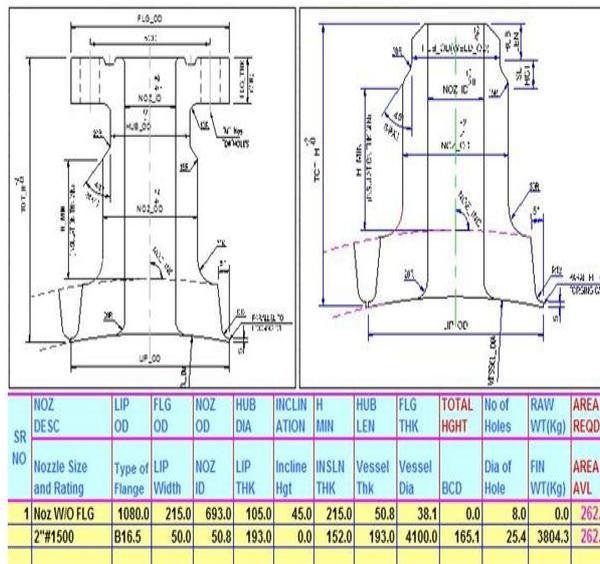


Fig.6 output of program

### B. Results

The sheet where all of our drawing view construction is called a working sheet can create as many working sheets as our need. Each working sheet has a background sheet attached to it, that users can modify a drawing sheet's characteristics, such as the size and attached background sheet, background sheet to any number of working sheets, making them useful for any geometry that want to place on more than one drawing. Once the user will enter the required input parameters and close the excel sheet, the background sheet of nozzle drawing will be open in Solid Edge and the drawing will be modified as per the parameters entered. If the user wants to reedit some of the parameters then the user has to go to the required dimensions and can edit the same. It will give the final drawing nozzle with all dimensions.

### IV. CONCLUSIONS

At the time of enquiry of any project, it was found that time taken by estimator for estimating cost of nozzle is 4 to 5 days because estimation team may not able to estimate weight of nozzle until design of different nozzles and modelling of nozzles may not be prepared by designers and cad engineers.

By developing nozzle automation program, time taken by estimator to estimated weight of nozzle is been reduce from 4 days work to 4 to 5 hour work, Nozzle automation program provides output as designed data of nozzles, weight of nozzles as well as it provide automatically generation of 2-D drawing in solid edge software.

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