Study on Design of Casing of Steam Turbine

[1]Gayatri Choudhary,[2]Nishita Kispotta,[3]Dhaneshwari Sidar,[4]Prakash Kumar Sen,[5]Shailendra Kumar Bohidar

[1,2,3]Student,Bachelor of Engg.(Mechanical Engg.),
Kirodimal Institute of Technology,Raigarh,Chhattisgarh,INDIA

[4,5]Faculty,Mechanical Engg. Department
Kirodimal Institute of Technology,Raigarh,Chhattisgarh,INDIA

Abstract - The work involves design consideration, design checks and sensitivity analysis to achieve the design criteria to fulfill the structural requirement for mechanical integrity. During the last several year the primary changes to the design of steam turbine have focused on improving their efficiency, reliability and reducing operating cost. Siemens Power Generation, for example, has improved the overall efficiency and availability of its steam turbine by decreasing the steam flow energy losses in each of the steam turbine components. The steam entering the turbine is at 30 6degree centigrade and 6.32 bar. To get the most work out of the steam, the exhaust pressure is kept very low the casing thus witnesses, energy of the steam turned into work in HP and IP Stages. So the design of the casing is a very important aspect.

Keyword:-Steam turbine, objective of casing design, casing design, casing eccentricity.

I.INTRODUCTION

Steam turbines are one of the most versatile and oldest prime mover technologies still in general production used to drive a generator or mechanical machinery. Power generation using steam turbines has been in use for about 100 years. When they replaced reciprocating steam engines due to their higher efficiencies and lower costs. Most of the electricity produced in the United States today is generated by conventional steam turbine power plants. [1]

Steam turbines for the bottoming cycle of combined cycle plants had their unit capacity continuously increased as the combustion temperature of gas turbines became higher and unit capacity larger. The compact design of steam turbine, namely, single-casing turbine not only reduces the cost of the turbine itself, but reduces plant construction cost because of the reduced turbine size and shortens delivery time. The advantage of single-casing is particularly notable on the single-shaft combined cycle in reducing total shaft length, improving shaft system reliability due to the reduced number of rotors and enhancing operability and maintainability.[2]

II.OBJECTIVE OF CASING DESIGN

The engineer responsible for developing the well plan and casing design is faced with a number of tasks.

- The pressure difference is lost if pressure builds up in the casing.
- The valve must be required to prevents excessive pressure from damaging the casing .[3]
- Design strings to minimize well costs over the life of the well.
- Provide clear documentation of the design basis to operational personnel at the well site. This will help prevent exceeding the design envelope by application of loads not considered in the original design.

While the intention is to provide reliable well construction at a minimum cost, at times failures occur. Most documented failures occur because the pipe was exposed to loads for which it was not designed. These failures are called “off-design” failures. “On-design” failures are rather rare. This implies that casing-design practices are mostly conservative. Many failures occur at connections. This implies that either field makeup practices are not adequate, or the connection design basis is not consistent with the pipe-body design basis. [4]

III.METHOD OF CASING DESIGN

Casing Design Based on capable manufacturers’ experience in developing casing materials and construction for high inlet steam conditions, designs employ either a single- or double-shell construction. Both of these shell configurations have been used on many applications and have accumulated years of operation. Turbine casings are generally horizontally split and designed to provide reliable, leak-free operation with metal-to metal joints, moisture drainage provisions, and multiple casing inspection openings. The parts of the turbine that control the position of the rotating components in relation to the fixed components are supported and located precisely at shaft height: they move independently of each other. On large turbine casings distortion cannot be transmitted to the bearings. [5]

A. Preliminary Design

In the process of preliminary casing design the following

ISSN: 2278 – 7798

points must be noted

- Determination of casing shoe depths and number of strings.
- Data gathering and interpretation.
- Successfully met selection of hole and casing sizes.
- Mud-weight design.
- Directional design

The quality of the gathering data will have a large impact on the appropriate choices sizes and shoe depth.

B.Detailed design

The detailed design phase includes selection of pipe weights and grades for each casing string. The selection process consists of comparing pipe ratings with design loads and applying minimum acceptable safety standards (i.e., design factors). A cost-effective design meets all the design criteria with the least expensive available pipe.[6]

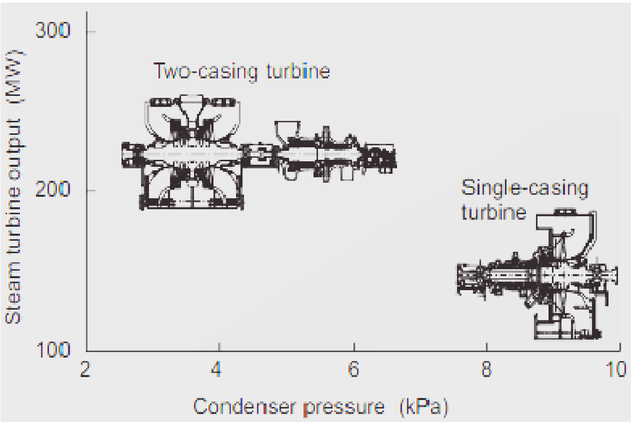

Fig.1. Steam turbine capacity and casing arrangement indicates the applicable range of output and condenser pressure for single-casing turbines.

The design procedure adopted in the present work is as given below because of the complicated shape of the turbine cylinder the exact calculation of the wall thickness becomes very difficult. Neglecting the effect of side walls flanges the pressure and temperature variation along the length.

The flange of a turbine cylinder operates under condition of compression and bending. Their design is however based only on the bending forces present the forces acting on the flange and the bolts. [7]

Fig.2.Inside casing

In Table 1 [8] important parameters are given. And this Table shall be adopted to design the steam turbine casing.

TABLE 1
IMPORTANT PARAMETER

Description			**Units**
Inside pressure	P1	5	MPa
Outside pressure	P2	0	MPa
Inner diameter	D	610	mm
Allowable stress	Q	72.5	MPa
Assumed ratio of flange height to casing thickness	h/t	2.9	
Bolt diameter	d	42	mm
Bolt thread pitch	p	4.5	mm
Bolt pitch	t	84	mm
Cap nut diameter	n	58	mm
Distance from casing outer edge to bolt	k	20	mm
Distance from bolt to casing inner edge	f	18.47	mm

IV.CASING ECCENTRICITY

With mechanical analysis of casing under non-uniform load, there is a hypothesis in modeling and deduction. It is very important to take casing off-center into consideration for casing safety evaluation in the evaporated beds. According to the casing mechanical analysis under non-uniform load, the most risk area is the points that have 90 or 270 degree. For the casing in deep ground, longitudinal deformation is limited. If we do not think about the longitudinal deformation, the problem can be transformed into a plane strain one. In the fig.3: the casing radius is a0, the cement sheath's radius is a, the layer's a1.

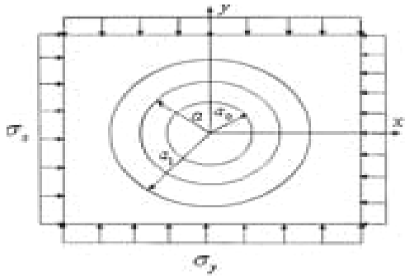

Fig.3. the mechanic model of the stratum-cement sheath-casing system

In the finite element analysis of stress, we make a 3D model of casing. For the casing length is much longer than its diameter, the end effect is neglected. We can select the cross section of casing and cement sheath to set their geometry model, and then mesh and solve the problem. Casing stress calculation involves material properties of the casing, and the following parameters are as follows: [9, 10]

The elastic modulus of casing:	210 GPa;
The poisson's ratio of casing:	0.3
The elastic modulus of cement ring:	7 GPa
The Poisson's ratio of cement ring:	0.18

A. High-performance reliable low-pressure exhaust casing

The new turbine uses a downward exhaust casing and has bearings laid directly on the foundation to ensure shaft reliability.

The LP side gland casing which is independent of the LP casing and connected to it through bellows also ensures reliability against casing deformation caused by vacuum loads, etc. The exhaust casing uses an asymmetrical flow guide to improve pressure recovery and reduce pressure loss.

B. High-performance axial-exhaust casing

The shaft arrangement above enables axial-flow exhaust of the steam turbine. This in turn dramatically reduces exhaust loss using a high-performance axial exhaust casing with higher pressure recovery than with

Downward exhaust. Axial-exhaust, where the condenser can be installed on the same floor, enables lower the turbine deck and building, compared to downward exhaust where the condenser is installed underneath the steam Turbine.[11].

V.CONCLUSION

Large-capacity single-casing reheat steam turbines have been developed to meet the need for large-capacity single-shaft combined cycle plants and the market demand for reduced cost by using compact machines, enhanced flexibility of the operation, and high performance. The present study on strength of steam turbine casing for a given operating conditions reveals that the optimized casing geometry shall be used as design modification for future.

REFERENCES

[1]. Energy and Environmental Analysis (an ICF International Company) 1655 North Fort Myer Drive Suite 600 Arlington, Virginia 22209

[2]. Watanabe et al., Development of High Efficiency and Reliability Low Pressure End Blade, Mitsubishi Juko Giho Vol.38 No. 2 (2001)

[3]. Resources Development Corporation Technologies for learning 13831 Northwest Freeway, Suite 520 Houston, Texas 77040-5215(713)460-4460(800)527-1851

[4]. Adams, A.J. and Hodgson, T. 1999. Calibration of Casing/Tubing Design Criteria by Use of Structural Reliability Techniques. SPE Drill & Compl 14 (1): 21-27. SPE-55041-PA.http://dx.doi.org/10.2118/55041-PA

[5]. Heinz P. Bloch (West Des Moines lowa)

[6]. Adams, A.J. and Mac Eachran, A. 1994. Impact on Casing Design of Thermal Expansion of Fluids in Confined Annuli. SPE Drill & Compl 9 (3): 210-216. SPE-21911-PA.

[7]. Ramesh,J.Vijaya,B.R.,&V,J.,2013.,Designand analysis of HP steam turbine casing for transient state condition.

[8]. Shlyakhin, P., 2013.Steam turbine: Theory & design. Moscow: Foreign language publishing House [translated from Russian by A.Jaganmohan]

[9]. Ferda Akgun, Petroleum Institute, U A E; Shedid A. Shedid, Hamed H. Al-Ghadban, UAE University, Simulation

[10]. S.M.Willson, A.F.Fossum&J.T.Fredrich, Assessment of Salt Loading on Well Casings [J]. SPE 74562, 2002.

[11]. Watanabe et al., Development of High Efficiency and Reliability Low Pressure End Blade, Mitsubishi Juko Giho Vol.38 No. 2 (2001)

