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USING FINITE ELEMENT ANALYZING FOR CALCULATION OF STRESS-STRAIN CONDITIONS OF WEDGE GATE VALVES BODIES

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Summary: *Authors considered the possibility of FEA application realized in software ANSYS for durability estimation of parts of wedge gate valve. Use of ANSYS allows to carry out the SSC analysis, taking into account the features of detail geometry entirely, and to realize the combined interdisciplinary analysis. This fact allows to refuse a strength margin increased by a factor of three, provided in analytical method, and to design more optimal construction.*

1. Introduction

Strength analysis is used for examination of valves parts strength. In general case in analysis stress values and margin of safety are determined in parts material by using data of force calculation (Gurevich, 1964).

Loads received by valves parts can be divide into basic loads and additional loads. Basic loads are loads created by environment pressure and loads appearing in process of manipulation of valves. Additional loads are loads appearing at assembling and in process of operating of valves (influence of fluctuation in temperature, water hammers and others) (Gurevich, 1964).

The fact is generally accepted that all features of operating of valve can not be considered. Therefore valves are calculated taken into consideration only basic loads. At the same time stresses appearing because of additional loads are overlapped by designed margin of safety (Gurevich, 1964).

With evolution of computer techniques software realizing numerical methods of theory of elastics such as finite element analyzing (FEA) is commonly used for stress-strain conditions (SSC) analysis of details with complex geometrical shape (Syzrantsev & others, 2002). Using of this software is allowed to analyze SSC of parts taken into consideration geometrical features of integrally parts that is difficult by analytic methods, and also is allowed to realize interdisciplinary analysis. The ability of using FEA for calculation of valves SSC is shown in

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work (Syzrantsev & others, 2002).

2. SSC and stiffness calculations of gate wedge valves bodies by analytic methods

Usually calculation of gate wedge valves bodies and covers is made for different elements: walls, flanges and others. However valves bodies and covers walls have irregular shape, therefore their calculations are made separately for different regions as a rule (Gurevich, 1964).

Further calculation with taken into consideration additional factors such as joint surfaces of different regions is made by very simplified methodic, that does not allow to estimate influence of different regions to each other. This method is based on following assumption: material of each region of valve body is loaded only from pressure on this region; walls of valve on one region have not an influence on value and distribution of stresses in other regions; flanges, stiffening plates, regions of flutes have not an influence on durability of separated regions.

As analytic method recommends wall thickness with thrice-repeated margin of safety under calculated wall thickness (Gurevich, 1964) conclusion that this method is not effective or that additional loads has significant influence to SSC has been made.

The calculation of valves bodies is not limited by strength analysis. For guaranteeing of reliability work of gate wedge valves their bodies must have enough rigidity to keep flap containment under operating environment pressure (Gurevich, 1964).

Valves bodies and covers can be examined as irregular shape shell for calculation of maximum deformation. However this estimation is made very seldom because they need a lot of complex calculations. Therefore estimation is made by still more simplified method considering the body section on mainline flange axis as beam lying on two foots (Gurevich, 1964).

3. SSC and stiffness calculations of gate wedge valves bodies by FEA

Authors have realized analysis for two rated cases: body loading by internal pressure at opened flap and body loading by internal pressure with force along spindle that providing flap containment at closed flap. Quality of finite element meshing has been estimated as differents between values of equvivalent stress in points of integration of elements and values of equvivalent stress averaged in nodes (Crawford, 1999). Equivalent stresses field calculated by finite element analyzing of first and second rated cases are shown at figures 1 and 2.

In analytic methodic only uniform loading of valve body is considered, therefore we shall use first FEA rated case date with averaging of equivalent stress over cylindrical region of body and over cylindrical region of body with region under stiffening plate is for further comparing FEA and analytic results.

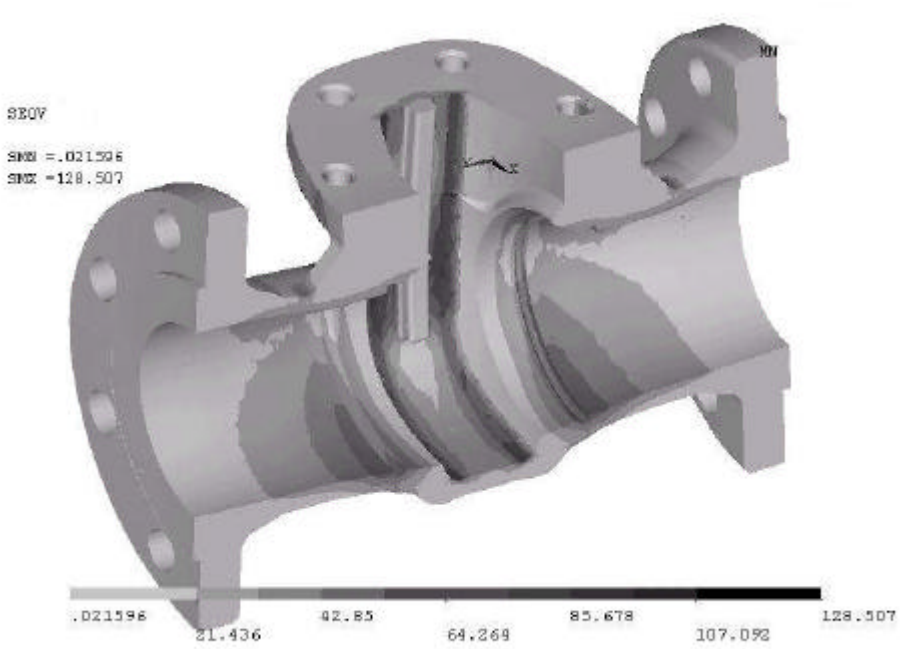

Figure 1. Equivalent stress field at opened flap, MPa

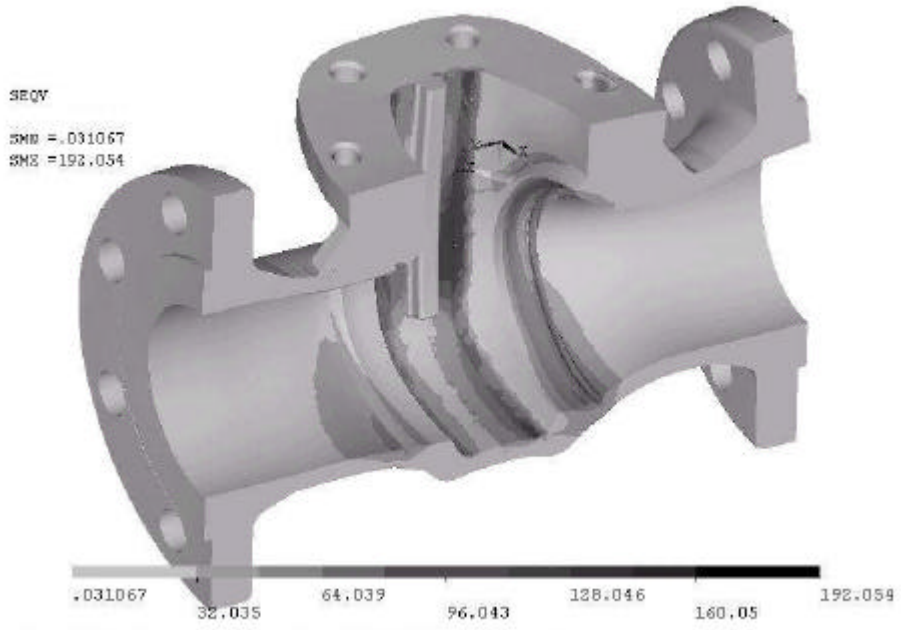

Figure 2. Equivalent stress field at closed flap, MPa

The conclusion that basic assumption in analytic methodic about absence of influence of different regions to each other is not true has been made after analyzing ratio errors of analytic method results and FEA averaging results (3,364% and 20,905% for first and second regions of body) with taking into consideration that ratio error is 0,336% for task of long pipe under internal and external pressure (Birger & Panovko, 1968). Therefore using of this methodic without correction factors does not applicable for wall thickness determination of cast valves with complex geometry or stiffening plates.

Summary displacement field in valve body calculated by FEA is shown on figure 3. Maximum values of deformation calculated by analytic method ($4{,}5 \cdot 10^{-5}$ mm) and FEA (0,017713 mm) are differed more than 300 times therefore comparing of these values does not possible. However it is obvious that maximum value of deformation calculated by FEA is closer to reality that is confirmed during acceptance and longevity testing of wedge gate valves. Therefore using of analytic method for gate valves middle or large diameters with complex geometry does not possible.

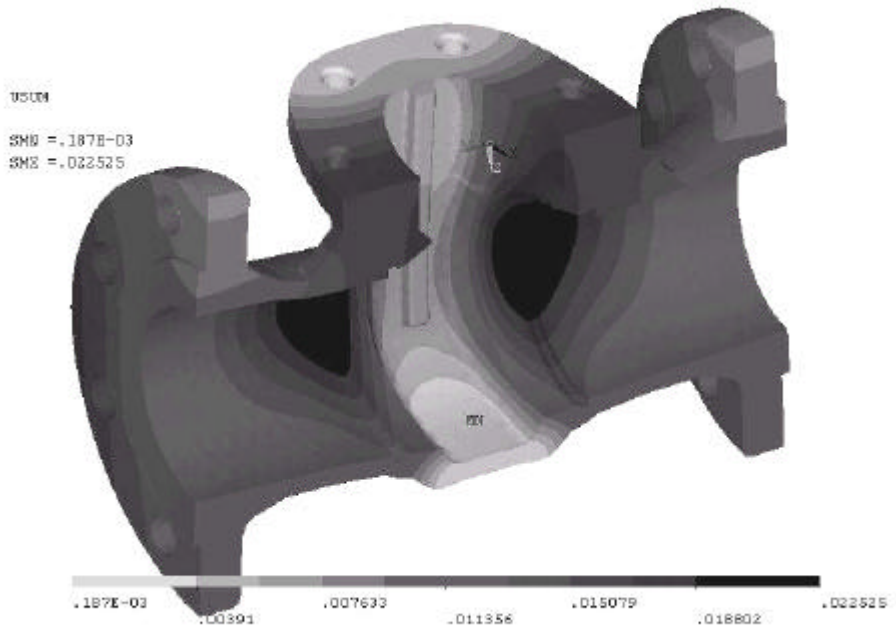

Figure 3. Summary displacement field, mm (deformations are increased at 1000 times)

The real loads operating in valves can be determinate with the help an Integral Strain Gauges (ISG), which register accumulated strains of detail surfaces (Syzrantsev, 1993). Places for gluing of ISG can be specified on the basis of FEA calculation and than loads receiving valves in operational can be established by gauges reaction.

4. Conclusions

Analytic method is taken no account real stress-strain conditions of valves depending on service conditions therefore it can be used only as preliminary estimation in prime stages of designing process.

As in present time main data about real loading of valves often are absent new method of SSC calculation based on FEA with ISG data will allow to estimate lifetime and safety factors of design valves more exactly and also to predict remaining life of operating valves.

5. References

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