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THE STUFFING BOX PACKINGS MAINTENANCE BASED ON COMPUTER AIDED TECHNICS

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S u m m a r y
One of the most important problem in stuffing box packing maintenance is the establishing of aver-tightening time rate. The stress evolution in the sealing gasket is influenced by the gasket's material properties, the initial tightening pressure and the gasket's length. The paper presents a computer aided method, based on finite element analysis, for over-tightening time rate establishing providing this way valuable information for the sealing optimal maintenance

Keywords: *stuffing box sealing, over-tightening time, finite element analysis*

1. INTRODUCTION

The stuffing box seal for shafts is one of most spread sealing system used even there are some major drawbacks, like the necessity of periodic maintenance, high power loses due to the gasket-shaft friction etc.

Based on the effect of transformation, in the gasket material, of axial the pressure, from the tightening lid, in the radial pressure, on the shaft, the stuffing box functioning is mainly influenced by the gasket material quality and behaviour. Due to rheological behavior of these [1], the value of the contact pressure between gasket and the sealed shaft is decreasing in time. Periodical tightening of the gasket compensates this diminution.

The rheological aspect of the material behavior is generated both by his internal structure and by the used knitting technology.

The stress relaxation curves, experimentally obtained, for three types of materials used for stuffing box gaskets are presented in Figure 1.

It comes out that the stress relaxation speed for the tested materials is decreasing from high values, in the first minutes after tightening, to a minimal (stabilized) value reached after a lapse of time depending by the material and the obtaining technology of the gasket.

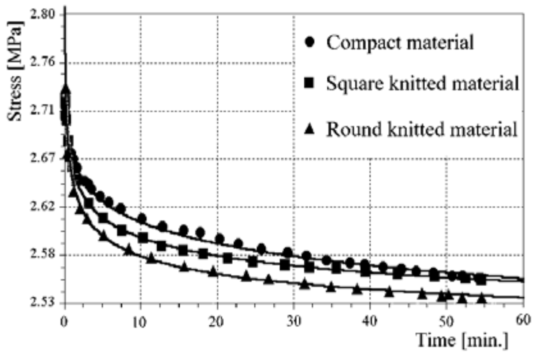


Fig. 1
Stress relaxation curves for some stuffing box gasket materials - PTFE, compact (P-NF) and knitted – round cross section and square cross section (Teadit 2006)

2. OVER-TIGHTENING TIME RATE ESTABLISHING

Used methods for establishing the optimal over-tightening time rate generally starts from experimentally acquired data.

Classically, the decreasing time rate for the axial stress in the sealing gasket can be computed based on the equation [1]:

$$P_{at} = P_{a0} e^{-\beta t} \qquad (1)$$

where:

P_{at} - axial stress at time "t";

P_{a0} - axial stress at initial time;

β - experimentally established coefficient.

Based on the sealing functioning requirements (P_{at}), the over-tightening time rate (t) is established following the equation (1).

The main drawback of the method is that it require heavy test rigs and a real-like sealing, the β coefficient being computed based on some experimentally data, Figure 2 [2].

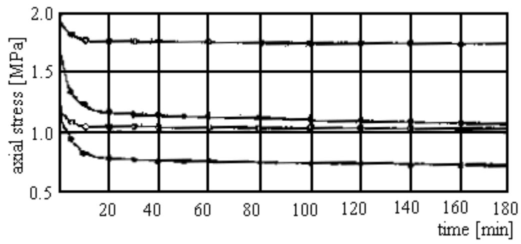


Fig. 2

Experimentally data referring to β coefficient

The proposed method is based on finite analysis modeling for the gasket material behaviour.

Starting from the generalized Zener model for visco-elastic materials behaviour under stress (Figure 3) [3], the constitutive equation was obtained:

$$\sigma_{(t)} = \int_0^t 2G_{(t)} \frac{\partial \Psi}{\partial \tau} \partial \tau + \int_0^t K_{(t)} \frac{\partial \Phi}{\partial \tau} \partial \tau \qquad (2)$$

where:

$G_{(t)}$ -relaxation function of tangential modulus;

$K_{(t)}$ - relaxation function of bulk modulus;

Ψ - tangential deformation variation function;

Φ - volumic deformation variation function;

τ - relaxation time.

In the particular case of stuffing box gasket, the material behaviour is described only by the $K_{(t)}$ and his expression is:

$$K_{(t)} = K_{\infty} + K_{\tau} e^{\frac{t}{\tau^{K}}} \qquad (3)$$

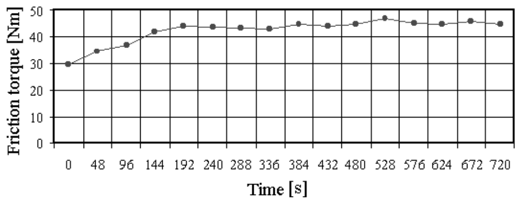
where:

K_{∞} - stabilized value of bulk modulus;

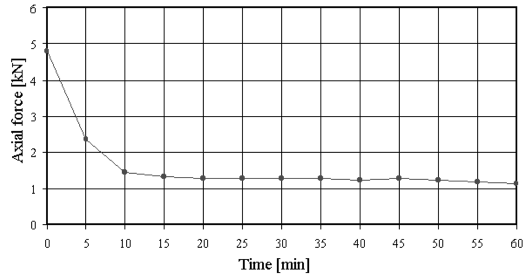
K_{τ} - bulk modulus relaxation coefficient.

Based on these equations a finite element model was build, using the Cosmos/M professional F.E.A. package.

The input data for model are the gasket's material characteristics, experimentally acquired [4] (gasket-shaft friction torque and axial force variation), Figure 3.



a)



b)

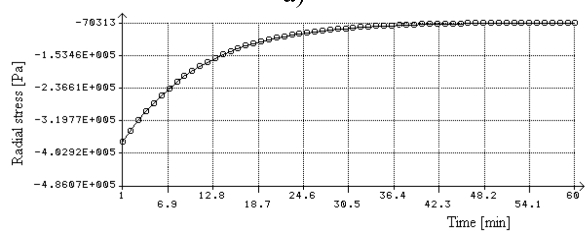
Fig. 3

Experimentally acquired input data for finite element analysis

a) friction torque variation in time; b) axial force variation in time.

The running of the analysis allowed obtaining (for a particular stuffing box packing) both the values and the evolution in time of radial stresses in the gasket, Figure 4.

a)



b)

Fig. 4

Output data from finite element analysis

a) radial stress values; b) radial stress evolution in time

The simulation allow also obtaining the behaviour of the gasket in case of over-tightening, Figure 5.

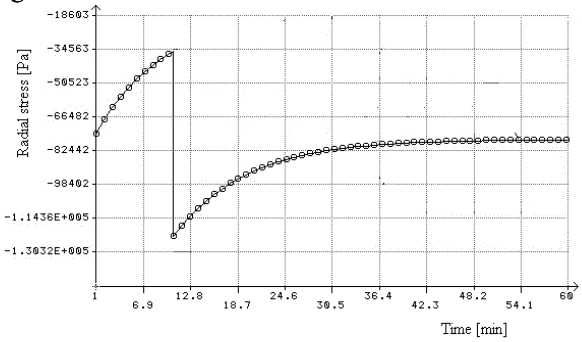


Fig. 5
Radial stress evolution in time with over-tightening

Based on the F.E.A. output data the radial stress decreasing can be fit:

$$\sigma_R = C_1 + C_2 t + \frac{C_3}{n} + C_4 t^2 + \frac{C_5}{n^2} + \\ + C_6 \frac{t}{n} + C_7 t^3 + \frac{C_8}{n^3} + C_9 \frac{t}{n^2} + C_{10} \frac{t^2}{n} \quad (4)$$

where:

σ_R - radial stress in the gasket;

C_{1-10} - fitting coefficients;

t - time value;

n - gasket's ring number.

3. CONCLUSIONS

The presented method allows establishing the optimal over-tightening time for stuffing box seals.

The test rigs used are common ones, the finite element analysis needing only few general characteristics of gasket's material.

The method allows to optimize the seal's maintenance procedure by precisely time rate establishing for the over-tightening operation.

4. REFERENCES

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