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INVESTIGATION OF THE CAUSES OF THE CRIMINATION OF TURBINE CASTINGS AFTER OPERATION OF 100 THOUSANDS. HOURS[23]

Tkachenko D., master of group MC-55-23
Kharkiv National Automobile and Highway University

Abstract. *One of the most important tasks of power engineering is to increase the reliability and performance of turbine parts. In our work, the research material was casting of a steam distribution housing made of steel 15Х2М2ФБС turbine Pridneprovskaya state district power station after operating 100 thousand hours. One of the main factors preventing the formation of a stone-like fracture is the purity of steel and, above all, the absence of sulfides and nitrides.*
Key words: *turbine, stone-like fracture, steel purity, sulfides, nitrides.*

ДОСЛІДЖЕННЯ ПРИЧИН ОКРИХЧУВАННЯ ВИЛИВКІВ ТУРБІН ПІСЛЯ ЕКСПЛУАТАЦІЇ 100 ТИС. ГОДИН

Ткаченко Д.М., магістр групи МС-55-23
Харківський національний автомобільно-дорожній університет

Анотація. *Для оцінки стану металу і прогнозування довговічності корпусів блоку клапанів паророзподілу доцільним є дослідження структури виливків після тривалих термінів експлуатації. У нашій роботі матеріалом дослідження був виливок корпусу паророзподілу, виготовлений зі сталі 15Х2М2ФБС турбіни Придніпровської ГРЕС після експлуатації 100 тис. годин. Показано, що одним з головних чинників, що перешкоджають утворенню каменеподібного зламу, є чистота сталі і, перш за все, відсутність сульфідів і нітридів.*
Ключові слова: *турбіна, кам'яноподібний злам, чистота сталі, сульфіди, нітриди.*

One of the most important tasks of power engineering is to increase the reliability and performance of turbine parts. During the operation of castings of turbines in a metal, structural transformations occur, which results in a change in the level of mechanical properties. Individual turbine parts operate under very difficult conditions. So, the valve block of steam distribution works under conditions of a difficult stress state with an alternating loading cycle, being subjected to various types of deformation - tension, compression, shear, etc.

To assess the condition of the metal and predict the durability of the valve body of the steam distribution valve block, it seems advisable to study the structure of castings after long periods of operation. In our work, the research material was casting of a steam distribution housing made of steel 15Х2М2ФБС turbine Pridneprovskaya state district power station after operating 100 thousand hours. To study the state of the metal after operation, metallographic and electron microscopic analyzes were performed.

The nature of the fracture was studied using electron diffraction studies of the surface of fractures using a scanning microscope. As shown by metallographic studies, the structure of the casting consists of bainite, ferrite and ferrite-carbide mixture. During operation, the decomposition of bainite into a ferrite-carbide mixture and the differentiation of structural components are observed.

The study of the mechanical properties of the metal after operation showed that of all the properties, the toughness is most significantly reduced. Typically, when evaluating the properties of

[23] Робота виконана під керівництвом професора Глушкової Д.Б.

heat-resistant steels, a low level of toughness at 20 ° C is alarming, since it is assumed that such "embrittlement" reduces the ductility of steel and can cause accidental destruction of the metal in operation.

To obtain complete information about the structural state of the metal after operation, the microstructure of fractures was studied. The need for such a study is due to the fact that the feature of steel 15X2M2FBS is the presence of a stone-like fracture. In the table 1 shows a comparison of the impact strength with the microfractographic characteristics of metal fractures. The ever-increasing needs of modern engineering raise an acute question about the use of steels prone to stone-like fracture.

So, in [1], a theory of the formation of a stone-like fracture was developed, which relates the appearance of this defect to precipitation from austenite during slow cooling after overheating of non-metallic impurities — sulfides — due to a change in solubility with temperature.

Table 1. Comparison of microfractographic characteristics of the fracture of the casting with the number of sections of the stone-like fracture and the values of impact strength

impact strength, j / cm^2	stone fracture percentage	micrographic signs of plastic deformation
65	80	fracture areas with accumulation of pits of various sizes, mainly small
55	10	the accumulation of pits alternate with traces of micro bursts, there are tongues and ridges
23	30	the fracture surface consists of facets of quasi-splits and steps
15	-	grooves of fatigue with a rough steep relief, elements of a brooky pattern

As can be seen from a comparison of the results given in table. 1, the presence of a large percentage of stone-like fracture is not accompanied by brittle fracture. Thus, in the presence of 80% stone-like fracture, accumulations of small dimples are observed in fractograms, which is a hallmark of fracture.

Particles with a higher tendency to form a stable stone-like fracture are studied on the chips of the samples by electron fractal studies. It can be sulfide inclusions, nitride phase. Local enrichment of grain boundary volumes with such inclusions leads to the fact that subsequent heat treatment cannot “remove” these particles from the boundaries of former austenitic grains, and they appear to be “fixed”, and the boundaries are sharply weakened, hence the stone-like fracture.

It should be noted that the sections of the stone-like fracture are fragile and viscous.

A comparison of the microstructure with the fractures indicates that one of the causes of the stone-like fracture is large grain.

Another reason for the appearance of a stone-like fracture is the presence of impurities in steel in the form of sulfides or nitrides, which are located at the grain boundaries and weaken them.

The nature of the destruction is affected by ferritic layers around the bainitic grains, which, participating in the destruction, form a streamy pattern.

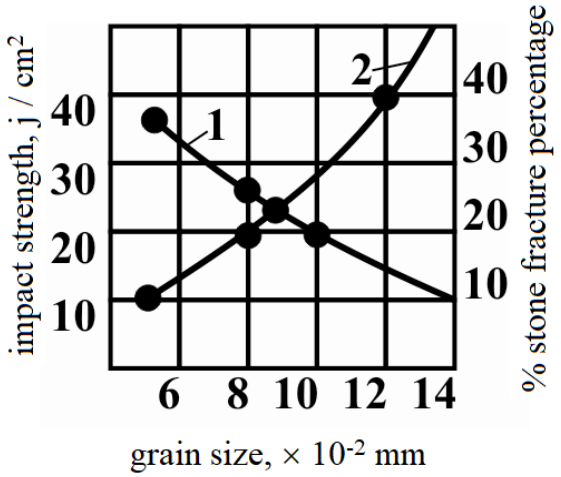

Figure 1 - The relationship between toughness and fracture structure parameters: curve 1 - between toughness and grain size; curve 2 - between the percentage of stone-like fracture and grain size

Summarizing the results obtained, we can say that a stone-like fracture can be brittle and viscous. If, for some reason, either related to the initial heat treatment, or to the operating conditions, the cold brittleness threshold is shifted to the right, in this case a stone-like fracture is accompanied by brittle fracture.

Conclusion

1. One of the main factors preventing the formation of a stone-like fracture is the purity of steel and, above all, the absence of sulfides and nitrides.

2. Overheating of steel during preliminary or final heat treatment makes grain boundaries weakened. Subsequent operation, which takes place under conditions of elevated temperatures and stresses, leads to the fact that the grain boundaries are the place where local enrichment with inclusions occurs, which contributes to the formation of a stone-like fracture.

Literature

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