Analysis of Technical Supervision over Water Supply Pipeline

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Abstract. The main function of technical water supply systems of hydropower stations is for cooling and lubricating water equipment, which is directly related to the safe and stable operation of water turbine generators, water cooled transformers and other important equipment. In this paper, two cases of technical water supply system fault are analysed in detail to illustrate the importance of manufacturing and installation of technical water supply system in ensuring stable operation.

1 Introduction

The technical water supply system of hydropower stations mainly serves hydro-generators, water-cooled transformers, water-cooled air compressors and other water-cooled assisting equipment. The main function of technical water supply is to cool and lubricate water equipment [1-3]. As water volume and water quality of hydraulic press play a role in the operation of the system, stable operation of technical water supply system is considered particularly important. Leakage of the technical water supply system could flood the workshop in addition to possible suspension of important equipment. Therefore, supervision of the technical water supply system is absolutely necessary.

2 Test Method

The pipeline and flange were tested by physical, chemical and non-destructive testing. The physical and chemical testing methods included metallography and tests of hardness and chemical composition. The non-destructive testing methods included test of penetration and ultrasonic thickness

3 Results and Analysis

3.1 Joint flange cracking

In a hydropower plant, it was found that the connection flange of the water supply pipeline cracked during regular inspection. The flange connected a flow control valve on the water supply pipe sealed by the main shaft of Unit No.1. Located under the head cover, it was not easy to spot. The unit was model DN40, with a flange made of nominal material 1Cr18Ni9.

On-site macroscopic inspection showed that water supply pipes and flanges were connected by welding. To facilitate on-site installation of the pipelines, flanges and

pipelines were not welded vertically but tilted at a certain angle. The flange was bolted, but there was a trace of forced closing. It could be seen from Fig.1 that the cracks on the flange were penetration cracks.

Fig.1 crack of the joint flange

(1) Chemical composition analysis

Results of the flange test are shown in Table1, revealing that the material of the flange met the standard.

Table 1 Flange Material Composition

element	Requirement of standard	sample
C	≤0.15	0.014
Si	≤1.00	0.92
Mn	≤2.00	1.67
P	≤0.035	0.023
S	≤0.03	0.012
Ni	8.00~10.00	9.17
Cr	17.00~19.00	18.16

(2) Hardness test

The mean value of flange hardness was 260HBW (Table 2), which is lower than the requirement of the standard [4].

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Table 2 Hardness Test for the flange

order number	hardness(HBW)					average
	1	2	3	4	5	
1	260	262	255	258	265	260

Fig. 2 Metallographic structure of flanges

Flange is made of stainless steel, a nominal material called 1Cr18Ni9. Tests revealed that the chemical composition of the flange conformed to the standard while the hardness and metallographic structure failed to meet the requirements. As a typical type of austenitic stainless steel, 1Cr18Ni9 is supposed to be all austenitic for normal metallographic structure, and austenitic plus martensite for the flange metallographic structure. Martensite has higher hardness in the metallographic structure, which explains why the flange has a higher hardness above standard. Martensitic structure deformation in austenitic steel could take place if the workpiece is not annealed after processing.

During installation, the water supply pipeline and the flange were connected in an oblique way instead of standard vertical connection to ensure a good flange fitting. But oblique connection cannot guarantee that the sealing surface of the two flanges is well sealed. in order to ensure that the flange seal watertight, they can only be

(3) Metallographic analysis

Analysis of the flange revealed a metallographic structure consisting of austenite and martensite (Fig. 2), an abnormal structure below standard.

forced to close, with the actual force much greater than the standard force. At the same time, unstandardized flange manufacturing process would result in abnormal structure of the flange with higher hardness. Under the long-term action of large joint force, the flange would crack, resulting in water injection [5].

3.2 Pipe weld leakage

During the inspection of a hydropower plant, it was found that the weld joint bend of the pipe in a unit had local leakage. The pipe was welded on site when the plant was established, which had been operating for over 30 years.

(1) Appearance inspection

The elbow was welded poorly, with a large proportion of the inner wall being unwelded, as shown in Fig. 3 and Fig. 4

Fig.3 External and Internal Morphology of the Pipe Weld Joint Elbow

Fig.4 Unwelded Inner Wall of the Elbow

(2) Wall thickness detection

The wall thickness of the connected pipeline was tested, and the results are shown in Table 3. A total of 22 weld joint elbows were tested, 12 of which had a wall thickness difference of more than 1mm. These pipe elbows were assembled and welded on site during installation of the unit. The uneven thickness of the elbows' pipe wall indicated unstandardized welding procedures.

Table 3 Measurement of Pipe Wall Thickness of Weld Joint Elbow in Water Supply System

Order number	Specification of pipe fittings	Detection value				Maximum wall thickness difference
		1	2	3	4	
1	DN300 Elbow	8.5	9.9	9.9	9.8	1.4
2	DN300 Elbow	9.8	9.4	9.9	9.5	0.5
3	DN250 Elbow	9.5	8.7	9.2	8.1	1.4
4	DN300 Elbow	8.5	9.4	9.6	9.1	1.1
5	DN250 Elbow	11.2	9.9	8.7	/	2.5
6	DN200 Elbow	9.6	8.9	10	/	1.1
7	DN300 Elbow	8.9	8.8	7.4	9.2	1.8
8	DN200 Elbow	8.1	7.2	7.2	6.6	1.5
9	DN250 Elbow	7.6	6.9	/	/	0.7
10	DN300 Elbow	9.9	8.9	9.3	9	1.0
11	DN300 Elbow	9.2	8.2	9.1	7.9	1.3
12	DN300 Elbow	8.1	9	8	9.5	1.5
13	DN250 Elbow	10	9.4	8.7	9.1	1.3
14	DN300 Elbow	9.8	8.6	9.4	10	1.4

4 Conclusion

The materials, manufacturing and installation of the technical water supply system are directly related to its follow-up operation. The metallographic structure of flange is austenite plus martensite, an abnormal structure with a hardness below standard. Poor flange installation and forced closure result in flange cracking due to long-term excessive joint force. The wall thickness of weld joint elbows is uneven, with some of the joints not fully welded. These factors, along with poor welding quality, lead to the rupture and water injection at the weld joint. Therefore, it is necessary to carry out technical supervision in the manufacturing and installation of the technical water supply system to ensure its safe operation.

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