

## Failure Analysis of Pipe System at a Hydroelectric Power Plant

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**Abstract :** In this study, failure analysis of pipe system at a micro hydroelectric power plant is investigated. Failure occurred at the pipe system in the powerhouse during shut down operation of the water flow by a valve. This locking had caused a sudden shock wave, also called "Water-hammer effect", resulting in noise and inside pressure increase. After visual investigation of the effect of the shock wave on the system, a circumference crack was observed at the pipe flange weld region. To establish the reason for crack formation, calculations of pressure and stress values at pipe, flange and welding seams were carried out and concluded that safety factor was high (2.2), indicating that no faulty design existed. By further analysis, pipe system and hydroelectric power plant was examined. After observations it is determined that the plant did not include a ventilation nozzle (air trap), that prevents the system of sudden pressure increase inside the pipes which is caused by water-hammer effect. Analyses were carried out to identify the influence of water-hammer effect on inside pressure increase and it was concluded that, according Jowkowsky's equation, shut down time is effective on inside pressure increase. The valve closing time was uncertain but by a shut down time of even one minute, inside pressure would increase by 7.6 bar (working pressure was 34.6 bar). Detailed investigations were also carried out on the assembly of the pipe-flange system by considering technical drawings. It was concluded that the pipe-flange system was not installed according to the instructions. Two of five weld seams were not applied and one weld was carried out faulty. This incorrect and inadequate weld seams resulted in; insufficient connection of the pipe to the flange constituting a strong notch effect at weld seam regions, increase in stress values and the decrease of strength and safety factor

**Keywords :** failure analysis, hydroelectric plant, crack, shock wave, welding seam

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