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PEOPLE AND SYSTEMS FOR WATER, SANITATION AND HEALTH

Lusaka water network pipe failure

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THE LUSAKA WATER and Sewerage Company Limited (LWSC) is a private company providing water and sewerage services to the City of Lusaka. Lusaka is the Capital of Zambia and has an estimated population of 2.2 million people over a surface area of 360 square kilometers. The population growth rate of the City is estimated at 6.2%. Approximately 60% of the population lives in peri-urban areas while 40% live in conventional residential areas consisting of medium and low density areas. The need for a reliable and adequate water supply system is therefore, of great importance.

Water supply and pipe network infrastructure

Water Supply

The Lusaka Water and Sewerage Company, has an average daily combined production of 210,000 cubic meters of water from two sources, with each source producing about 50% of the total supply. Groundwater is abstracted from a total of 53 boreholes located around the City while surface water is from the Kafue River through a treatment plant at Iolanda Water Works located about 10 kilometers from the river intake. The treated water is conveyed to Lusaka over a distance of about 65 kilometers by way of a 900 mm diameter steel pipe and two highlift pumping stations one being approximately midway the conveyance distance at Mapepe 8 km outside Chilanga town.

Pipe network infrastructure

The Lusaka Water and Sewerage Company has a total of approximately 2,300 km of water transmission and distribution mains pipe network. About 47% of this network is of Asbestors Cement (AC), forming the bulk of the distribution mains network, while about 28% is galvanised Iron (GI). Transmission mains are mostly of steel, accounting for about 23% of the total network. The balance of transmission on pipes, about 2% of the network, are of unplasticised polyvingl chloride (up PVC) and Galvanised Steel (GS).

Possible causes of pipe failure

Generally, pipe failures in a water supply system which has no design problems, will arise due to the following: poor network control, poor maintenance and general management, hydraulic effects such as water hammer and transient pressures, electro-chemical effects i.e. corrosion and internal scouring, external caused such as intense loading from vibrations, shock and other mechanical stress inducers such as poor installation. The age of the pipe network and environmental causes pertaining to soils and temperatures can also lead to pipe failure. Water quality as well as vandalism and sabotage are other factors.

Steel and galvanised iron pipes

The Lusaka Sewerage Company has approximately 529 km of steel pipe transmission and distribution mains and 644 km of GI distribution mains.

The Kafue-Lusaka steel transmission mains

This line has been rather trouble free in terms of the outlined failure causes. It has a bituminous enamel and coal tar protection internally and externally respectively. The presence of a surge tank and air relief valves along the entire pipeline has further helped to eliminate hydraulic related failures. Vandalism to air relief valves is however, slowly compromising the favourable condition of the pipeline.

Despite the internal coating, the effect of corrosion and scouring/erosion over the average 30 years life of the pipeline has manifested itself in adverse internal pitting of the 6mm thick pipes, resulting in leaks under the high line pressures of the order of 24.2 bar. On further investigations the corrosion seems to be facilitated by the turbulence in the vertical pipe column of water thus causing scouring away of the coating.

Lusaka steel transmission and GI distribution mains

Failures experienced on steel and GI pipelines around the city have been of different nature but mainly point to unfavourable environmental conditions of corrosive soils in parts of the City. This is evidenced by frequent localised failures in certain sections of individual pipelines. Effects of transient pressures arising from interruption of supply due to various reasons such as upgrading or extension of the network, maintenance, rationing of supply etc, have also contributed. Effects of water quality do not seem to be a major contributor towards pipe failures of the Lusaka Water Sewerage Company network.

Asbestos cement pipes

Generally, AC pipes are renowned for their great resistance to corrosion and good hydraulic characteristics. AC pipes in the Lusaka Sewerage Company network have failed due to various reasons although age related failures due to deterioration of pipe strength seem to be more prevalent.

These effects have all led to failures of different modes under normal or sometimes inevitable transient pressures experienced in the network. Punch-size hole type of failures have been experienced and attributed to internal erosion and probably also at points that might have had a manufacturing defect originally.

Longitudinal cracks have been attributed to corrosion since failure over the entire length of pipe suggests uniform effect localised only to the particular failed pipe. A combination of both erosion and corrosion is however also possible as is evidenced from reduced pipe thickness along the crack assuming there were no manufacturing defects. Other failures due to externally induced mechanical stresses such as effects of various kinds of traffic, stress due to ground or rock movement or undergrowths such as tree roots etc have also caused failures in pipes.

Plastic pipes

Plastic pipes may generally be preferred due to their ease of handling, installation and low cost. PVC pipes in the LWSC network have failed mainly due to external mechanical stress related causes and hydraulic effects of transient pressures arising from interruptions in the supply system. Age related effects such as embrittlement have also been experienced. Failure modes have varied depending on the cause. Longitudinal failures have been experienced due to transcient pressures, while transverse crack have been experienced on pipes that were evidently stressed during installation, as well as pies that have been during installation, as well as pipes that have been subjected to shock loading.

Conclusion

The effects of frequent pipe failures can have far reaching negative results on a water supply system. Ingress of dirt under negative line pressure conditions and loss of revenue through loss of saleable water are some principal effects of a system prove to failures. Incidents of pipe failure need to be reduced to ensure that water quality is not compromised and that unaccounted for water (UFW is reduced. The Lusaka Water Sewerage Company currently has an average of 50% UPW, 30% of which is due to non-commercial losses of leaks in the trunk and distribution network as well as customer properties.

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