EFFECTIVE PROTECTION OF LONG PIPELINES BY TRANSIENT PROCESS THROUGH MEMBRANE, START-GIVING VALVES AND FEEDER TANKS IN PUMPING SUPPLY SYSTEMS

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The long pipelines have usually a length over 1000 m to several thousand meters. In that case a big direct water hammer arises during the transient process in pumping systems. Besides a dangerous interruptions of the water column could be observed. A new protection is proposed by a set of membrane valve, start-giving valve and feeder tanks (Fig. 1). The protection consists of a membrane valve (MV) and a start-giving valve (SGV) on a branch of the pipeline. With each pump a back-pressure valve (bpv) is included. Feeder tanks (FT) with air vessels (AV) are set on the peak bends of the pipeline. A control valve (cv) is mounted before the branch and elevation of upper level (EUL), resp. elevation of low level (ELL) are shown. The transient process includes five stages as follows (Fig. 2):

Stage 1. The flow is directed to the upper reservoir. At the same time the pump revolutions and the head are reduced. In the end of this stage the MV begins to flow and the head decreases till the value predicted by SGV (S_1).

Stage 2. Generally the minimum of the headline had been reached before the moment when unsteady flow arrived at the upper reservoir. The MV is open and the feeder tanks support the piezometric line high at the dangerous peak pipeline points (S_2).

Stage 3. The flow in the pipeline is directed partial to the MV (velocity is negative). One part of unsteady flow with positive velocity takes up the space of the pipeline and another one is occupied by steady motion. The MV continues to be opening while the SGV is closing till the limit of start-giving head (SGH). The piezometric line is raising slowly (S_3).

Stage 4. When the full length of the pipeline is spread all over by unsteady motion, the two valves are open completely. This state will continue to the total closing of SGV (S_4).

Stage 5. A new filling of membrane chamber begins depending on the size of diaphragm (S_5).

The different hydraulic structures are coupled together and connected with one object, i.e. the closing of one valve determines the operation of another one and so on. Thus the *Object Oriented Tools* is realized by means of nodes, branches, grid points and connections associated with one common structure, P. Ingeduld (1996). Numerical package is a set of static classes which include numerical methods like cubic splines, linear and non-linear systems,

Gaussian eliminations, iterative methods, etc. The set was tested in laboratory and was investigated by field study during the operation of a water supply pumping station. The numerical results were compared with "Kistler" transducers . The results point that the new protection is more effective, because firstly it leads to cost-effective design of pipelines with smaller head, resp. thickness and secondly it allows one pumping station without cavitations zones along the pipe provided the pipeline is tracing closed to the ground. The realization was made by authors' software by means of Object-Oriented Tools (OOT).

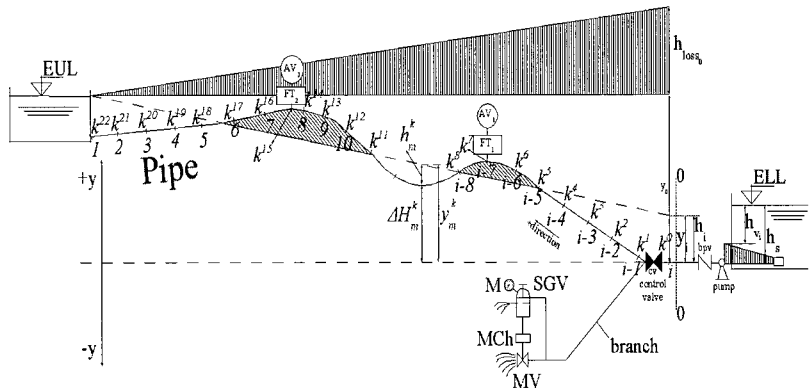

Fig.1 Scheme of pumping station with MV and SGV, AV on feeder tanks and BPV

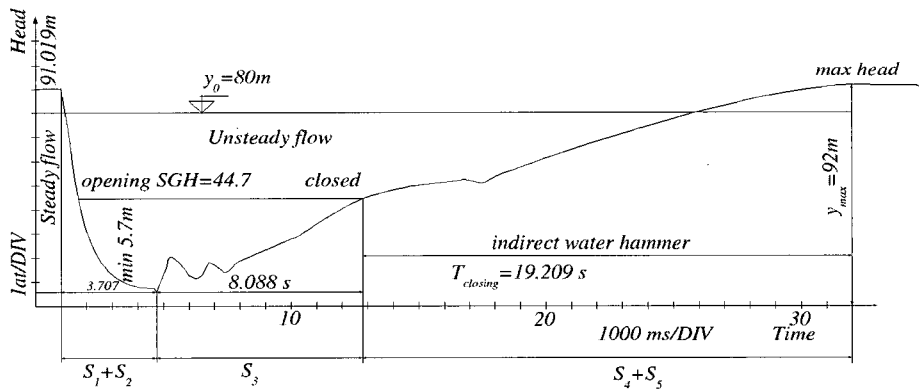

Fig. 2 Results obtained by numerical experiment

REFERENCES

N.Nikolov,M.Maradjieva(2003). Membrane Valve as Effective Protection of Pipelines During Transient process in Pumping Station, XXX IAHR Congress, Greece, themeD, pp.775-782.

P. Ingeduld, E. Zeman, A. Verwey(1996). Object-Oriented Tools for Transient Flow Analysis, NATO ASI Series, Env. 2, vol.15 Springer-Verlag, pp.451-463.