Journal of Young Scientist, Volume I, 2013
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

WATER HAMMER STUDY IN PRESSURE SYSTEMS UNDER TRANSITORY FLOW

Adrian COCOCEANU

Scientific coordonator: Prof.dr.ing. Eugen Teodor MAN

University "POLITEHNICA" of Timişoara, Faculty of Civil Engineering, Hydrotehnical Engineering Department, G. Enescu Street No. 1A 300022, Timişoara, Timiş County
e-mail: cococeanu.adrian@gmail.com

Corresponding author email: cococeanu.adrian@gmail.com

Abstract

The purpose of this paper is to obtain results through analytical modeling and physical behavior of pressure systems under transitory flow. Complexity of water flow, hypothesis and limitations of different equations governing the motion are studied by analysis using specialized software packages and validate the results obtained by measurements on experimental stands that shapet the physical phenomenon.

MATERIALS AND METHODS

The main directions pursued in solving the water flow in pipeline's under pressure are: determination of extreme pressures and parameters that defining transitory flow induced by the valve handling;design and implementation of an experimental stand for physical modeling of transitory water flow; results obtained from experimental measurements made on experimental stand that modeling the physical phenomenon.

Physical phenomenon of water hammer resulting from a rapid change in fluid velocity. Water hammer is an independent phenomena which arise when fluid flowing in a pipe is accelerated or decelerated.

The associated pressure transients can be damaging to pipework or components and systems must be designed to avoid or withstand them. The waves propagate velocity - the velocity of associated propagate waves through the fluid in rest is called celerity and is equal to the velocity of sound.

$$C = \sqrt{\frac{K}{\rho\left(1 + \frac{Kd}{t_p E}\right)}}$$

Value for celerity is essential for correct water hammer calculation, therefore, it is necessary to know his true value or to assess a value as close to the real one.

Basic equations that governing the motion in transitory water flow are the dynamics equation and continuity equation that modeling the water hammer physical phenomenon.

Continuity equation:

$$(E_1) \equiv \frac{c^2}{g}\frac{\partial v}{\partial x} + \frac{\partial H}{\partial t} + v\frac{\partial H}{\partial x} = 0$$

Dynamics equation:

$$(E_2) = \frac{\partial v}{\partial t} + v\frac{\partial v}{\partial x} + g\frac{\partial H}{\partial x} + \lambda\frac{v|v|}{2D} = 0$$

Water hammer equation system:

$$\begin{cases} \frac{c^2}{g}\frac{\partial v}{\partial x} + \frac{\partial H}{\partial t} + v\frac{\partial H}{\partial x} = 0 \\ \frac{\partial v}{\partial t} + v\frac{\partial v}{\partial x} + g\frac{\partial H}{\partial x} + \lambda\frac{v|v|}{2D} = 0 \end{cases}$$

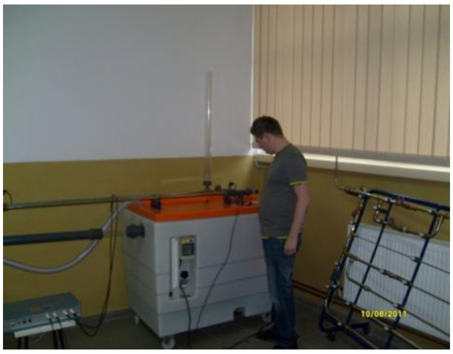

Figure 1 Experimental research on water hammer. Technical details of Armfield C7 Pipe Surg Apparature. Water supply stand Armfiel F1-10

Figure 2 Constant water tank

Figure 3 Signal Modulator hardware

Figure 4 Pressure transducer

Figure 5 BNC coaxial cable

Figure 6 Acquisition board hardware

Figure 7 Pipeline system

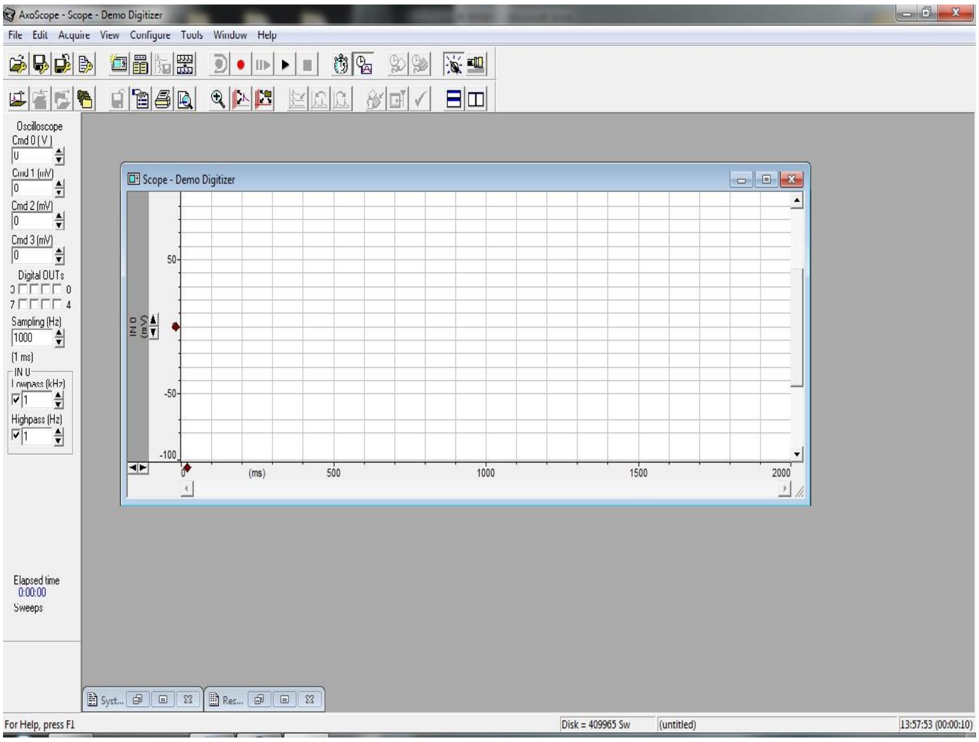

Figure 8 Software acquisition, representation and processing: AxoScope

Figure 9 Experimental scheme

Table 1 Experimental results

Volt/div A (mV/div)	Vertical Divisions N_v	Pressure P (bar)	Horizontal Divisions N_h	Period T ms/div	Signal Duration Td Ms
1	1	0.135	9	1000	9000
1	18	2.43	9	1000	9000

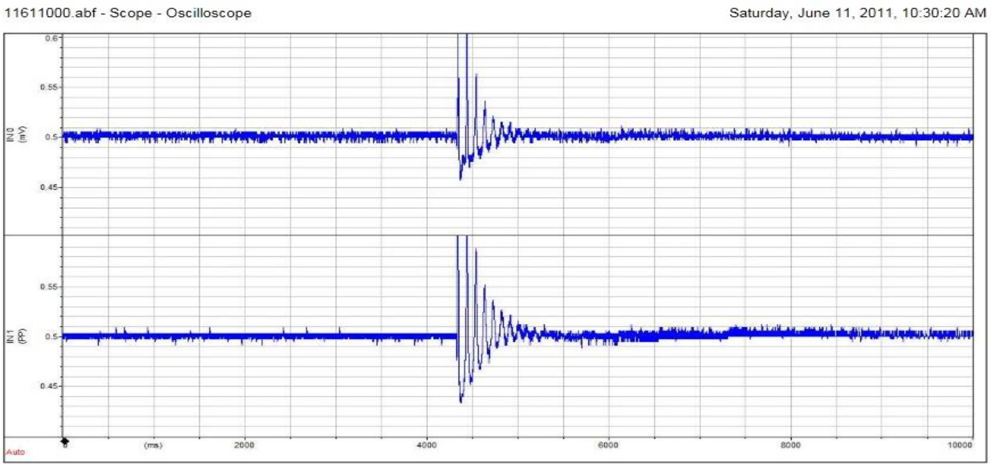

Figure 10 The appearance of water hammer acted with a quick closing valve - with valve open

Table 2 Experimental results

Volt/div A (mV/div)	Vertical Divisions N_v	Pressure P (bar)	Horizontal Divisions N_h	Period T ms/div	Signal Duration Td Ms
1	1	0.135	9	1000	9000
1	9	1.215	9	1000	9000

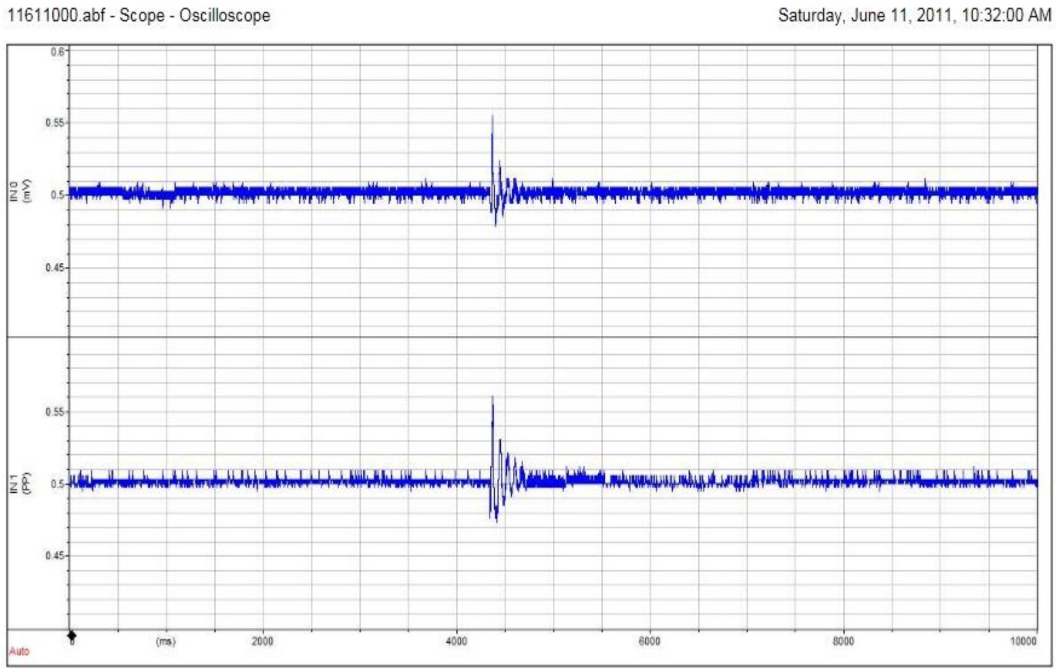

Figure 11 The appearance of water hammer acted with a quick closing valve - with partially open valve

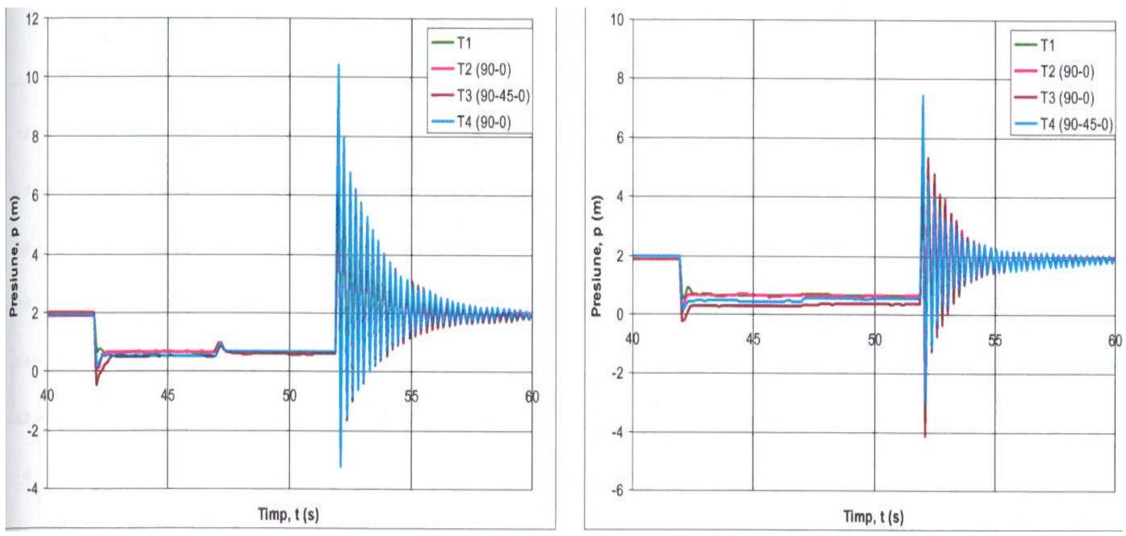

Figure 12 Comparative analysis of the variation of pressure
Results obtained by Dobre (Stănescu) M.:

The appearance of water hammer phenomenon in water networks systems under transitory flow .
In this case, was used the data processing program "Hammer" and the water supply network is a ring shape.

In the graphical representation of the left the water hammer phenomenon is observed with an amplitude higher than the plot on the right because in the right plot is represented the water supply system with partially open valve.

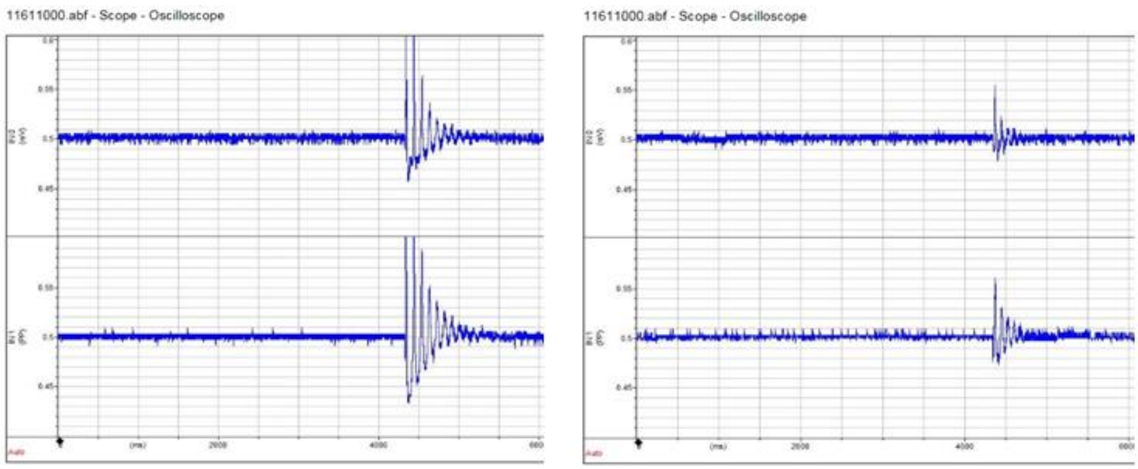

Figure 13 Results obtained by the author:
The appearance of water hammer phenomenon in water networks systems under transitory flow .

In this case, was used the data processing program " AxoScope" and the water supply network is a simple ramified network
It is noted in the graphical representation that the two data analysis results are similar results, which shows the accuracy of the results obtained from the experimental stand.

RESULTS AND DISCUSSIONS

Final and personal contributions
From the data analysis obtained by calculation, comparative analysis and experimentally, have been observed:

- effect of closing the valve on the pressure pipe is similar in both graphs obtained in experimental stand by the author, as well as those from the program, HAMMER of PhD.eng. Dobre (Stanescu) M.
- the maximum pressure is recorded
- is clear that in a pipeline network the customers connected by pipe hydraulic resistance are protected from pressure variations induced by the maneuvers of the valve.

CONCLUSIONS

In conclusion, from the comparing of the results obtained for the transitory regime,it results that the extreme values of pressure are perfectly covered by the results obtained by the program AxoScope.