2ND WORKSHOP ON APPLIED AND SUSTAINABLE ENGINEERING

THE IMPACT OF PRESSURE ON THE DISTRIBUTION OF WATER PULSES GENERATED IN THE SELF-EXCITED PULSE HEAD

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SUMMARY

Dynamic influence of water jet of periodically changeable structure is suitable in different areas of techniques. A special construction of self-excited pulsing head have been elaborated for that purpose. Computer simulation of its function let to develop and to optimize its construction as well as to determine the mechanism deciding of pulsing water jet generation. Examination of water jet generated inside the head show out occurrence of periodical changes in its internal structure as well as frequency of such pulses and its suitability for different materials erosion.

INTRODUCTION

Violent development in drilling assisted with pulsing water jet have been noticed in China's oil and gas mining recently. Such a jet generated in special construction work head characterizes with periodically floating pressure that ensures its momentary high energy [3].

Taking above into consideration it is advisable to use pulsing jet that ensures stream efficiency increase in comparison to traditional methods [1,2, 4, 5].

After analyzing different hydrodynamic phenomena realized in consequence of experimental simulations made in China University of Petroleum [3, 4], one can state that construction of proposed pulsing head can be essentially modified.

The paper presents modeling of self-excited pulsing heads and simulations results as well as experimental examinations realized in the laboratory.

The model of self-excited pulsing head

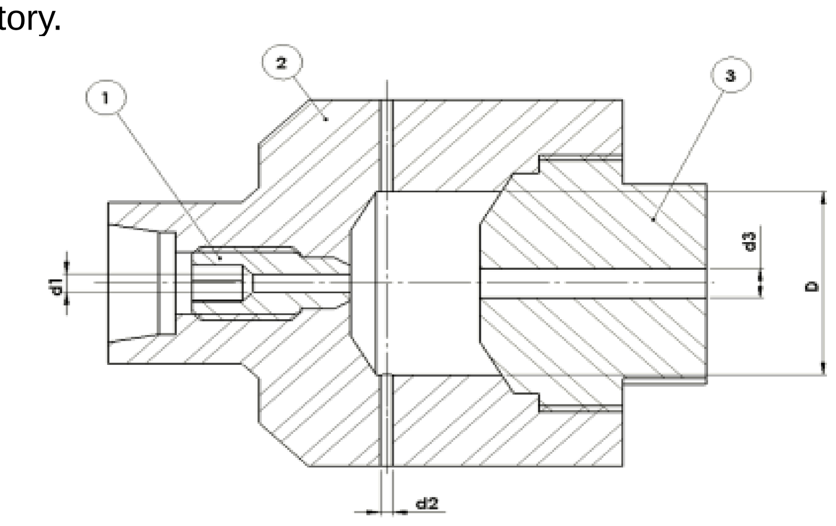

Fig. 1. The build of self-excited pulsing head: 1– inlet nozzle 2 - body, 3 – outlet nozzle (d1 – inlet nozzle diameter, d2 – lateral inlets diameter, d3 – outlet nozzle diameter)

Pressure distribution and water velocity analysis inside pulsing head

Computer simulations of phenomena occurring in self-excited pulsing head were realized using FlowSimulation program in order to define distributions of medium pressure and velocity occurring inside the head. They were carry out for different parameters and models of pulsing head, and thanks to their results it was possible to choose the most suitable construction for further analysis. Typical results of pressure distribution inside self-excited pulsing head realized during computer simulation are presented in Fig. 2.

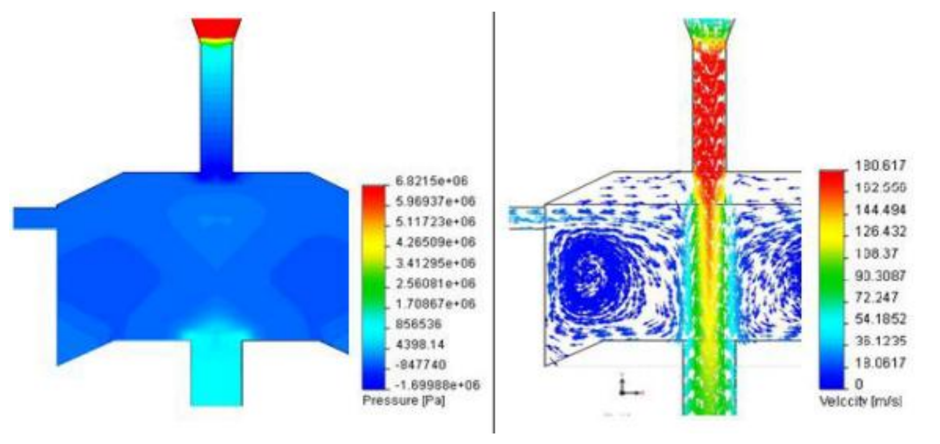

Fig. 2. Distribution of pressure and of liquid velocity vectors areas inside analyzed work head for medium inlet pressure of 15 MPa , a) pressure distribution , b) water velocity distribution

Experimental stand

General view of self-excited pulsing head and its basic construction are presented in Fig. 1. Head was made of chrome-nickel steel type X5CrNi18-9 presented in Fig. 3

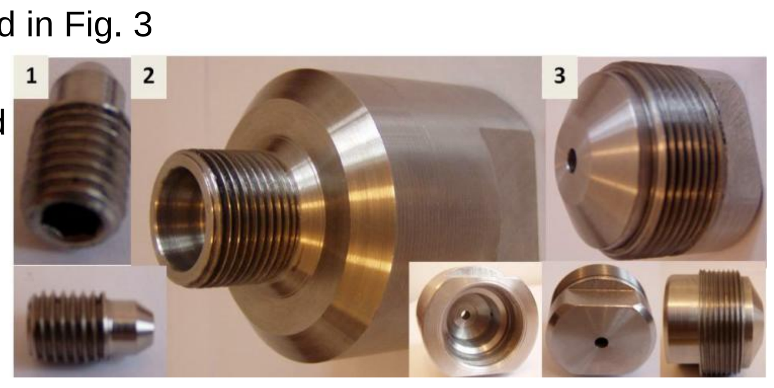

Fig. 3. Elements of self-excited pulsing head (1–inlet nozzle, 2-body, 3 – outlet nozzle)

A do experimental stand (Fig.4) was build for examining hydro dynamical phenomena occurring in the jet generated according to self-excited nozzle. Technologically such a test stand mainly consist of high-pressure hydro-monitor (1) type P30 and a chamber made of steel and glass (2) that is equipped with slidable high-pressure support with pulsing head (3) attached to. Bulletproof glass mounted along the front of the chamber let to monitor pulsing jet. A special high-speed Phantom V12.1 type camera (4) end piezoelectric force sensor type KISTLER-9602-AQ01 (5) coopering with PC computer as well as additional Dedolight COOLSET illuminators (6) were used for jet shape and flow intensity recording.

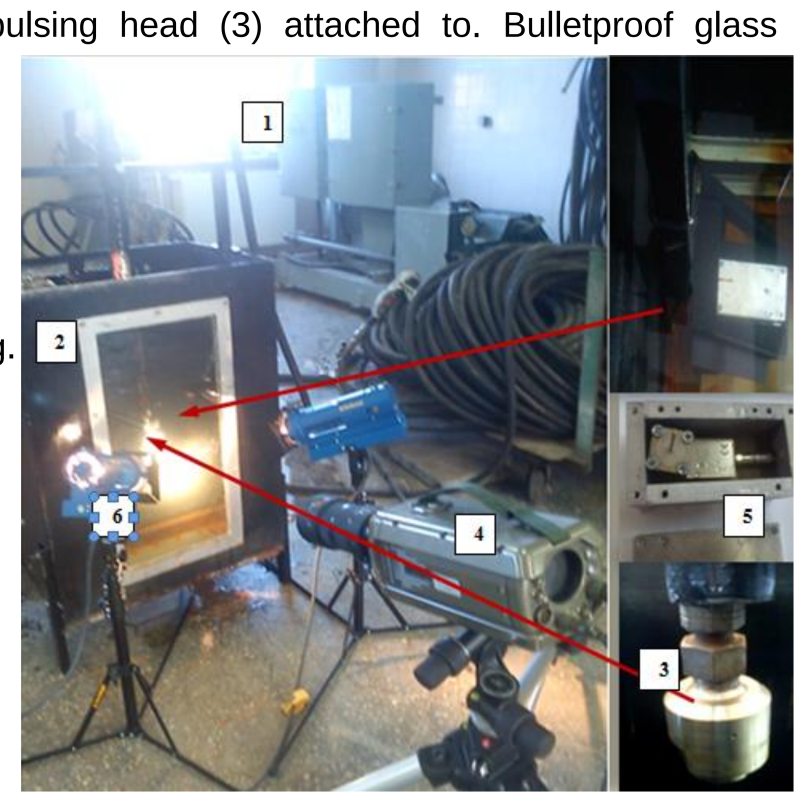

Fig. 4. Experimental stand for recording water jet generated in self-excited pulsing head (1 – hydro-monitor, 2 – experimental chamber including viewfinder, 3 – pulsing head positioned inside chamber, 4 – high-speed camera, 5 – piezoelectric force sensor, 6 – lighting)

Examining of jet shape and structure

Results (fig.5) pulsing jet shape was recorded using high-speed Phantom V12.1 type camera and it distinctly shows its discontinuity that may certify of the jet structure heterogeneity.

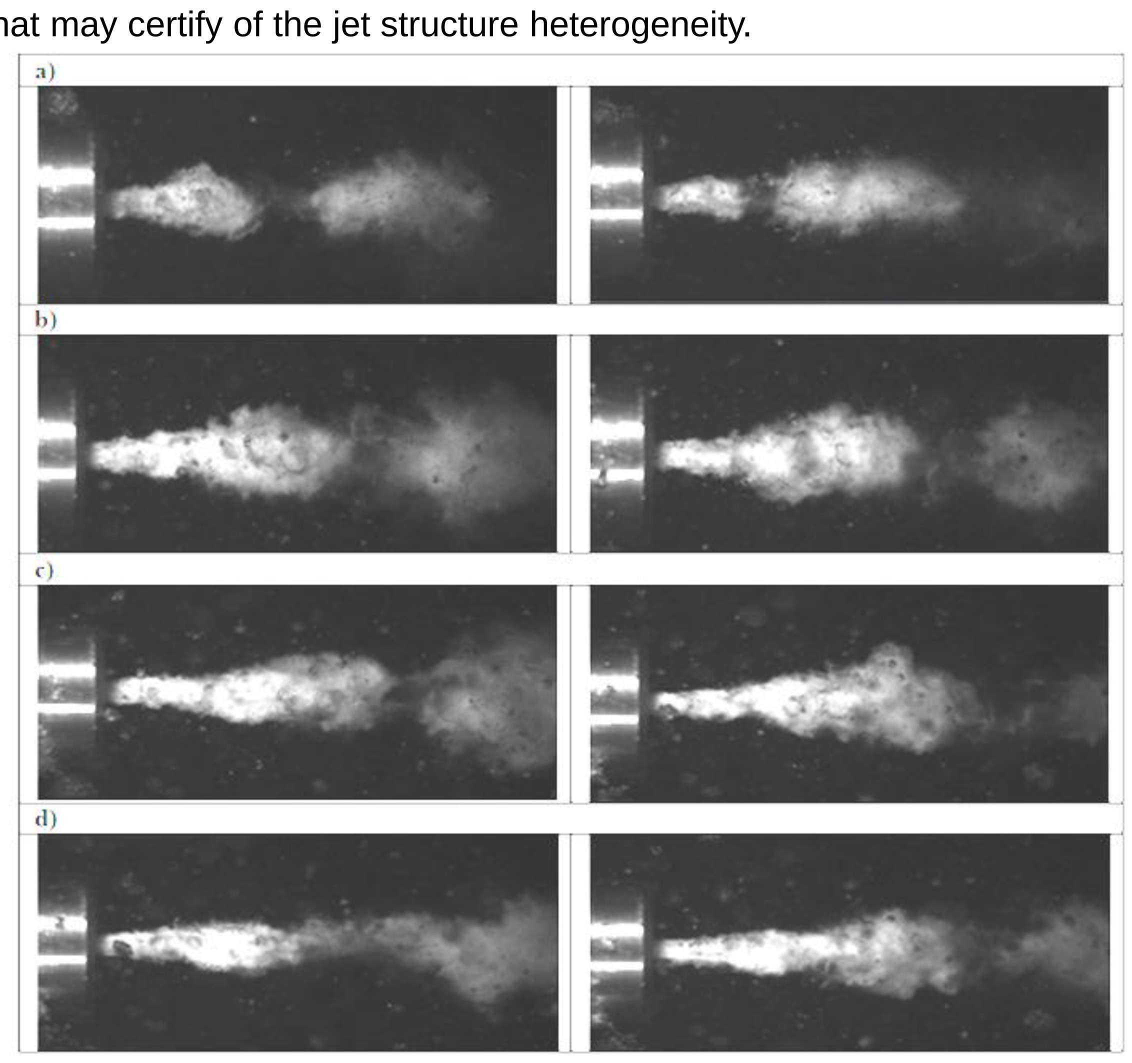

Fig. 5. Pulsing water jet submerged in water environment: a-10MPa, b-15MPa, c-20MPa, d–25MPa (head type: d1=2.5 mm, d2=2 mm, d3=4 mm)

Results of hydrodynamic pulses recording of water jet pressure generated in water environment - registering type sensor KISTLER-9602-AQ01 (Fig.6)

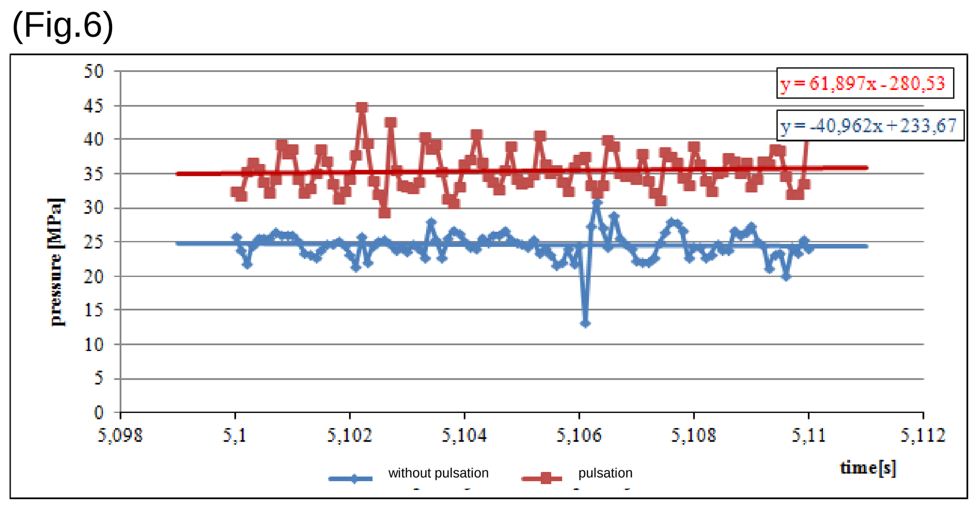

Fig. 6. Results of hydrodynamic pulses recording of water jet pressure generated in water environment (self-excited pulsing head type I, d1=2.5 mm, d2=2 mm, d3=4 mm, D=25 mm, H=15 mm, pressure 25 MPa)

Lp.	Pressure on the entrance to the head [Mpa]	piezoelectric force sensor KISTLER 9602-AQ01 [Hz]	high-speed camera Phantom V12.1 [Hz]
1	10	1500	1040
2	15	1000	800
3	20	800	640
4	25	800	600

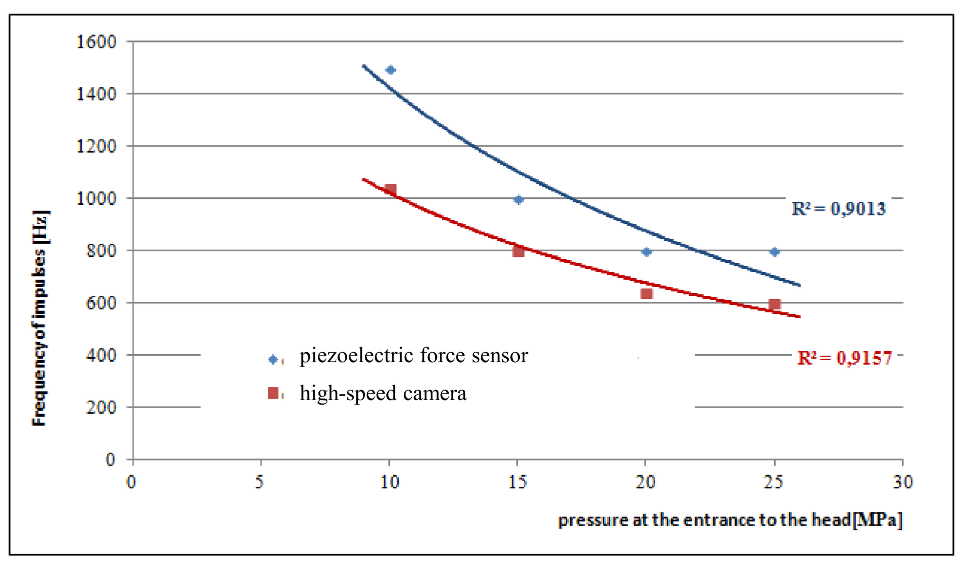

Fig. 7. Results of frequency distribution of the hydraulic pulse at different input pressures

CONCLUSIONS

Increase of nominal water pressure supplying pulsing head causes proportional increase of hydrodynamic pressure impulses in the jet and analogical increase of relative pressure. It should be noticed here that such impulses time elongates distinctly. Distribution of velocity and pressure vectors occurring inside pulsing head depends mainly on geometrical parameters of the head.

LITERATURE:

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