Application Bulletin
PIPENET® Transient Module Case Study

DISCHARGE TIME CALCULATION

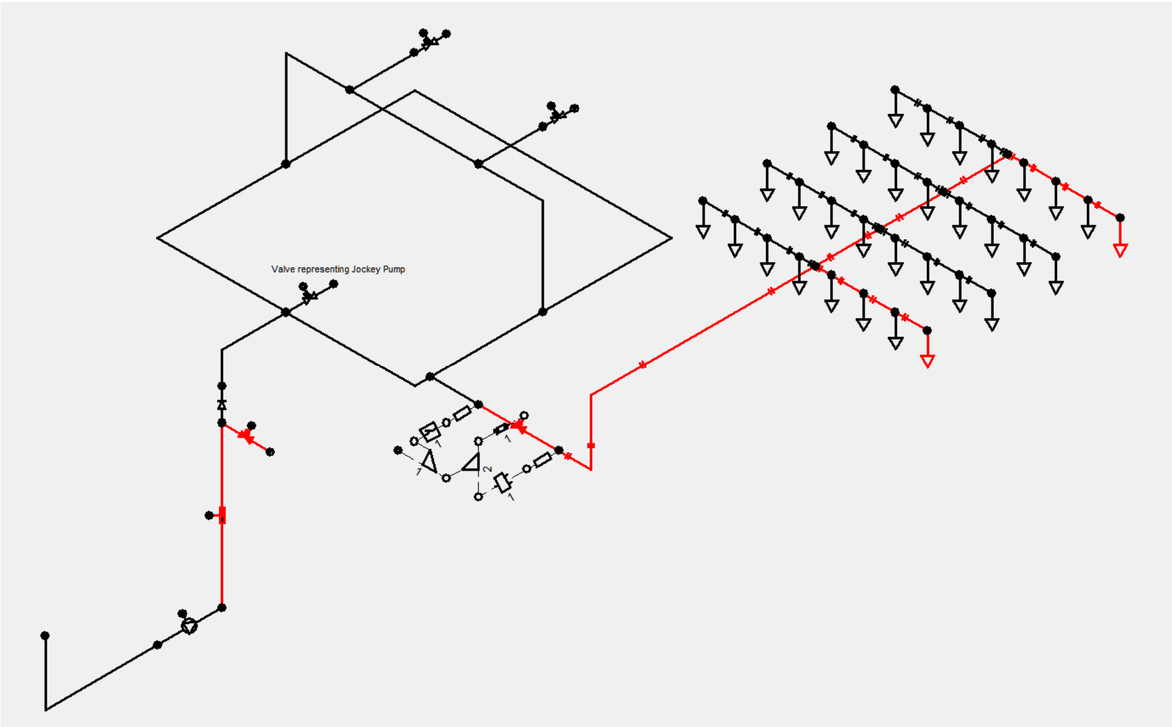
INTRODUCTION

It is clear that discharge time of a deluge system is of critical importance in its operation, especially if it works in conjunction with a firewater ringmain. In the case of offshore firewater systems, the sequence leading up to the last nozzles discharging water is complex. Hitherto the estimation of the discharge time has not been possible and it has not been a requirement of the NFPA rules.

This document shows that it is now possible to estimate the discharge time, even in the case of an offshore firewater system. In this case we will assume that an elastomeric deluge valve is used. Similar principles apply with 'clack' shut type of deluge valves.

THE NETWORK AND THE SIMULATION

The system considered for simulation purposes is shown in the schematic drawing below. The items of specific interest are shown in red.



A system such as this is complex from a simulation point of view and has the following stages.

1. During the quiescent state the ringmain pressure is maintained at 7 barg by a jokey pump.

2. On detection of fire the fire pump is sent a signal to start and the relevant deluge valve is sent a signal to open. It is assumed in this simulation that fire is detected 1 sec into the simulation. This is simply to show the steady state results before the dynamic event starts.

3. The dry riser pipe, often called 'the caisson' gets filled up with water. During this time air is expelled through an air release valve on the caisson.

4. When the caisson gets fully primed, water goes back to the sea through an overboard dump valve which is already fully open.

5. PIPENET simulation confirms that the caisson fully primes in less than 12 secs. For this reason the overboard dump valve is assumed to close from 12 to 17 secs (5 secs closure time)

6. It can be seen from the schematic that the deluge valve has a control system associated with it. The control system uses the following logic.

   - As mentioned in above point 1, fire is detected at 1 sec into the simulation. For this reason the system is assumed to be in its quiescent state during the initial 0 -1 sec.

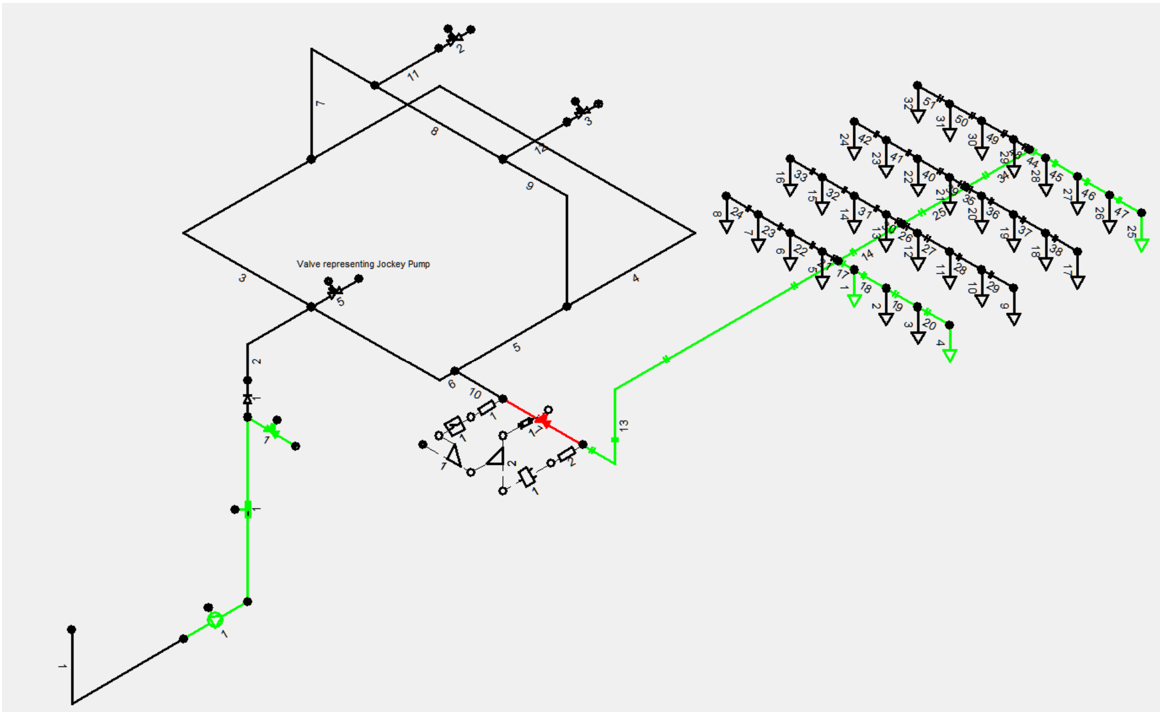
   - It is assumed that the minimum required pressure in the firewater ringmain for the elastomeric seal to operate is 2 barg.

   - Once the above conditions are satisfied the position of the deluge valve responds in order to control the downstream pressure at 7 barg pressure.

The network items for which graphical results have been chosen are indicated in green. This would allow us to follow the passage of water until it reaches the last nozzle.

In particular graphical results we will show the following:

- Priming of the caisson
- Operation of the overboard dump valve
- Operation of the elastomeric deluge valve
- How water primes the pipes in sequence until it finally discharges through the most remote nozzle.



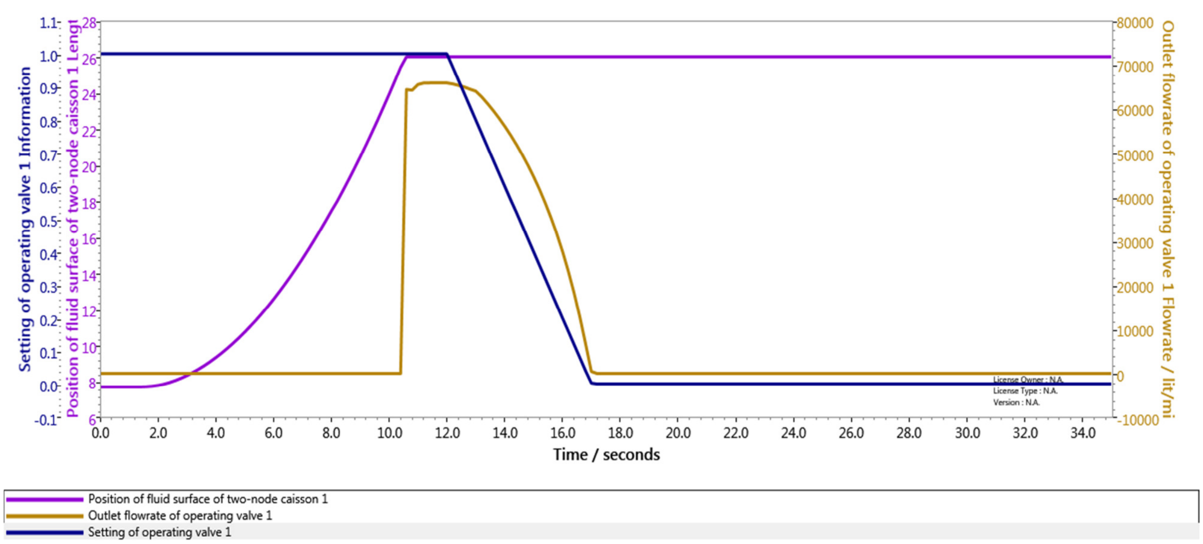
DISCUSSION OF THE RESULTS

Priming of the caisson

The purple line shows how the liquid level rises in the caisson. It can be seen that the water level reaches the top of the caisson at approximately 10.4 secs.

The blue line shows the position of the overboard dump valve. It can be seen that it starts to close at 12 secs and is fully closed by 17 secs.

The brown line represents the flowrate through the overboard dump valve. It rises instantaneously when the water level reaches the top of the caisson and decreases to 0 as the overboard dump valve closes.



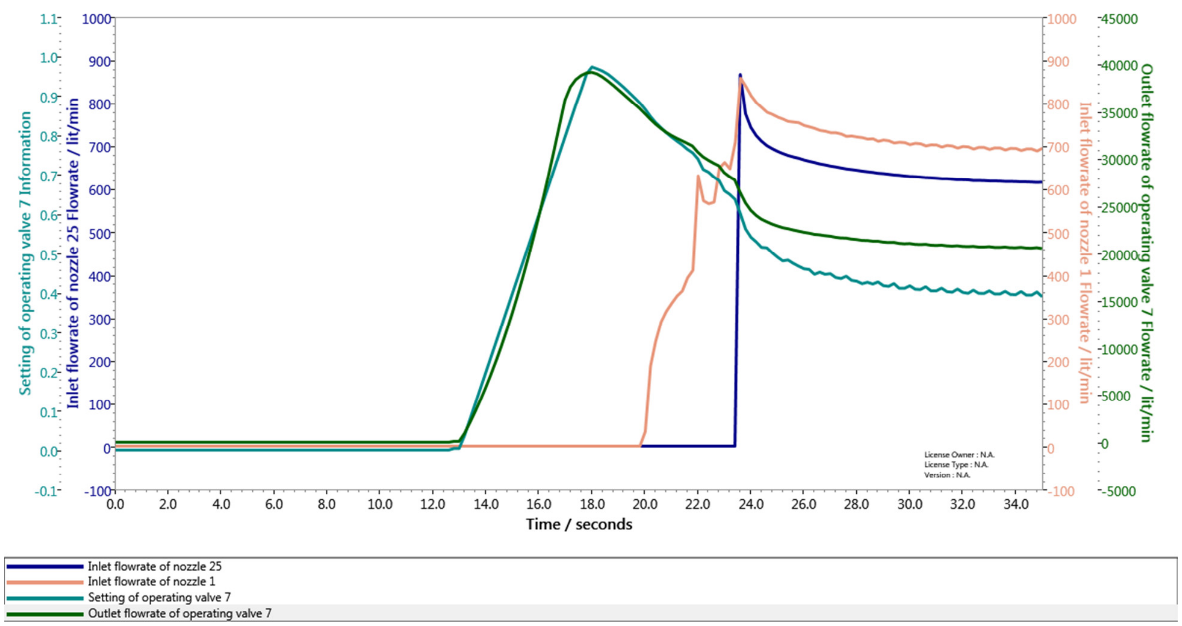
Operation of the deluge valve and the flowrate through the nozzles

The light blue line represents the position of the elastomeric sleeve on the deluge valve. It can be seen that its position overshoots before settling down at its final position. The overshoot occurs because the pressure downstream of the deluge valve is low to begin with and the deluge valve tries to compensate for this.

The green line is the flowrate through the deluge valve. It roughly follows the position of the deluge valve.

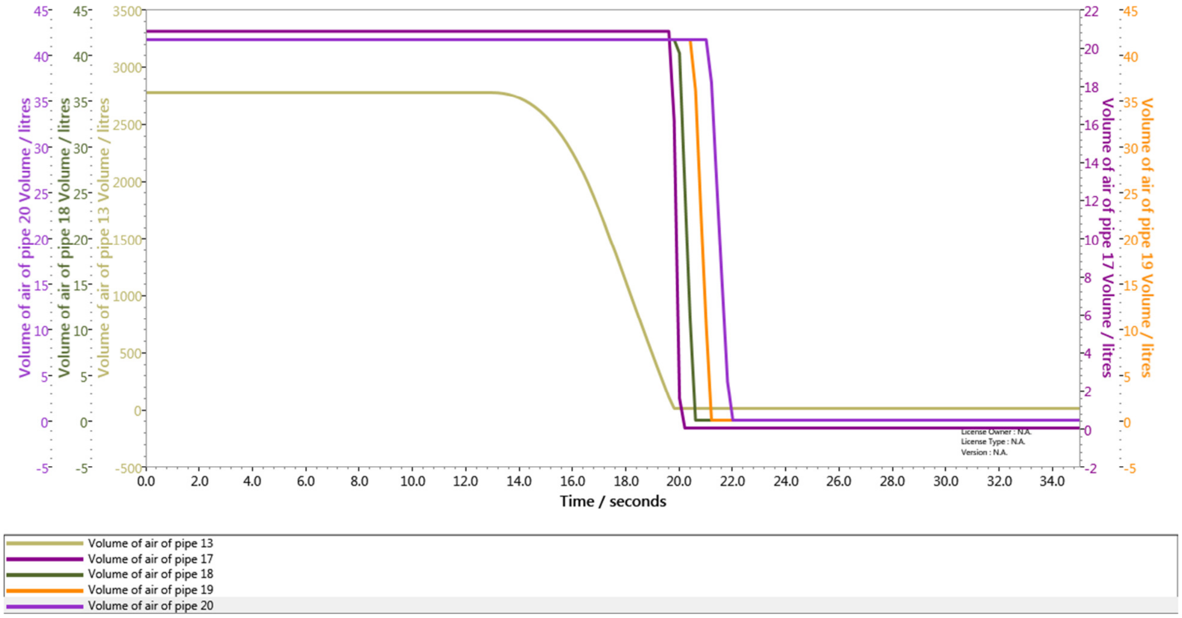
The pink line is the flowrate through the nozzle which is closest to the inlet of the deluge system. It discharges first.

The dark blue line is the flowrate through the most remote nozzle. The most remote nozzle discharges a full 3.6 secs after the nearest nozzle. When the water reaches the most remote nozzle, it creates a shock. This is because all the air has been expelled the water flowrate slows down with a shock. It can be seen that this shock travels back to the nearest nozzle and the flowrate through that nozzle momentarily overshoots before returning to its steady state level.



Expulsion of air from the pipes

It can be seen that the expulsion of air from pipes 13, 17, 18, 19 and 20 happens sequentially.



CONCLUSION

Calculation of the discharge time of firewater is one of the most complex simulation problems. Novel new techniques and methodologies are now available for estimating the time of air expulsion and discharge time calculation.

If you have any questions about this case study, or any other of PIPENET's capabilities, please email us at Pipenet@sunrise-sys.com.

Sunrise Systems Limited • Sunrise Business Park
Ely Road • Waterbeach • Cambridge CB25 9QZ • United Kingdom
Email: Pipenet@sunrise-sys.com • Web Site: www.sunrise-sys.com