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## Application of high pressure water in pipeline cleaning

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# Application of high pressure water in pipeline cleaning

Ying Zhu\*, Zhaoxing Meng and Haiqiang Lv

Shandong Xiehe University, Shandong, China

\*Corresponding author e-mail: zxin900@126.com

**Abstract.** The high-pressure water jet cleaning technology is used in the construction of ship cleaning project. The results show that the high-pressure water jet cleaning technology can effectively eliminate pipeline fouling blockage. After cleaning, there is no residual marine organism or other fouling on the surface of pipeline, and there are no surface defects such as thinning of pipeline wall, scratches and pits caused by cleaning. The high-pressure water cleaning technology is an effective way to clean seawater pipeline.

## 1. Introduction

Antifouling of seawater system is a key and difficult problem in corrosion and antifouling. Especially for large ships, antifouling problem is more prominent [1]. Due to the large size, complex trend and numerous equipment of large naval seawater pipeline system, the seawater flow lasts a long period, and the marine organism larvae carried in the seawater are easy to attach and grow in the pipeline and equipment. There are erosion and corrosion problems in seawater pipelines, and the phenomenon of depressurization in seawater pipelines has exacerbated the attachment and growth of marine organisms to a certain extent [2]. At present, the commonly used mechanical dredging and pipeline washing procedures are complex, heavy workload and long cycle. Some seawater pipes and valves are easy to adhere to marine organisms, which leads to the failure of the functions of pipes and valves. The long-term adherence of pipes to marine organisms without cleaning will affect the functions of the whole system, and even damage pipes and equipment [3].

It is very necessary to carry out regular anti-fouling cleaning of seawater pipes and valves by using mature marine biological cleaning technology to improve the anti-fouling ability [4]. In view of seriously polluted seawater pipelines, high-pressure water jet cleaning technology is used to clean ships, and a convenient and effective high-pressure water jet cleaning method for marine pipelines is established. High-pressure water jet cleaning technology has been widely used in cleaning automobiles, chemical heat exchangers and tanks, with the advantages of low cost, energy saving, environmental protection, high efficiency and so on. The high-pressure water jet cleaning technology used in this paper mainly relies on the high-speed water flow through the cleaning liquid jet cleaning technology, peristaltic nozzle self-rotating jet, to ensure the full coverage of the cleaning surface. The peristaltic nozzle can automatically move forward along the inner wall of the pipeline for cleaning, so as to improve the cleaning effect.

## 2. Analysis of working principle

The high-pressure water is produced by the high-pressure generator and the high-pressure water jet main machine (as shown in Fig.1), and reaches the nozzle through the water pipe matched with it, i.e. the



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high-pressure wire-wound rubber pipe. Water flow is ejected from the nozzle of the peristaltic nozzle. It can be seen that the cross-section of water flow suddenly becomes larger during the flow of water pipe, which makes the water with high pressure and low velocity change into the jet with low pressure and high velocity.

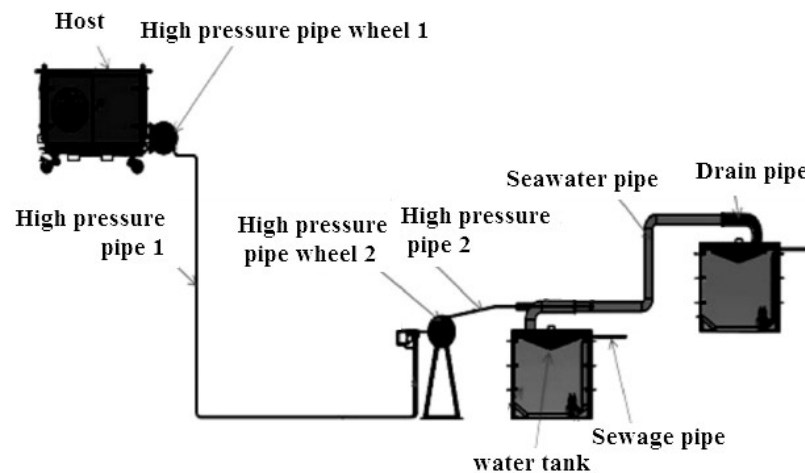


**Figure 1.** The process of high pressure water generation

The high velocity jet water impacts the cleaned surface forward or tangentially, produces impact force and shear force, and impacts on fouling, dynamic pressure, grinding, etc [5]. The fouling layer in the pipeline is eroded, penetrated, sheared and broken, and finally peeled off from the cleaned surface. The fouling is discharged by the high pressure water jet at the back of the sprinkler head, and the reaction force produced by the back sprinkler head will make the sprinkler head and high. Press hose forward and squirm nozzle forward to finish cleaning. Effective cleaning needs to ensure that the water jet uniformly and completely covers the entire pipeline, and complete the cleaning of all parts of the pipeline. The cleaning of algae, shellfish, grease scale and alkali scale in marine seawater pipes can be accomplished by high pressure water jet technology, and the pipeline will not be damaged.

### 3. Composition of cleaning equipment

#### 3.1. Working characteristics of equipment

The high-pressure pipe wheel contains 100 m high-pressure rubber hose, which connects the electric-driven high-pressure water pump with the adjustable speed rotator in the portable cleaning device of the engine room to transport high-pressure water. Each section of high-pressure water pipe is 20 m, and the maximum three sections of 60 m water pipe are connected according to the need. Rotary creeping nozzle is made of alloy steel. Precision drilling is carried out according to the different pressure and flow rate [6].

The drilling methods of 45 degree forward, 90 degree and 45 degree backward can meet the needs of different cleaning. The hydrostatic pressure provided by the high-pressure pump is converted into hydrodynamic pressure by the rotating peristaltic nozzle. The high-speed rotation and forward peristalsis of the nozzle are driven by the reverse moment produced by the eccentric moment on the rotating body of the nozzle. The maximum pressure is 150 MPa and the rotation speed is 50-500 r/min. The maximum diameter of the cleaning pipeline is 250 mm, the minimum diameter is 50 mm, and the segment length is not more than 20 m.

#### 3.2. Analysis of work scope

The pipelines of a ship's intermediate water fire extinguishing system were cleaned. The pipelines with 219 mm diameter and 159 mm diameter were 1500 m and 2070 m respectively. The pipeline material is

B10 copper-nickel alloy pipe. B10 pipeline has good erosion resistance, but also has strong corrosion resistance.

The pipeline is Fe-containing Cu-Ni alloy, which has a strong ability to prevent marine biological fouling. It is generally believed that the corrosion product film of cuprous oxide, which is toxic to marine organisms, formed on the surface of copper alloy plays an anti-fouling role. Adding iron to copper alloy can promote the formation of protective film, and the protective film formed has good corrosion resistance. The Fe-containing Cu-Ni alloy will form a dark protective film with good corrosion resistance. The corrosion resistance of the protective film is improved due to the presence of iron. Long-term use by sea water erosion, pipelines have varying degrees of corrosion and pollution, some pipelines are seriously polluted, a large number of marine organisms attached to the wall of the growth, as shown in Fig.2.

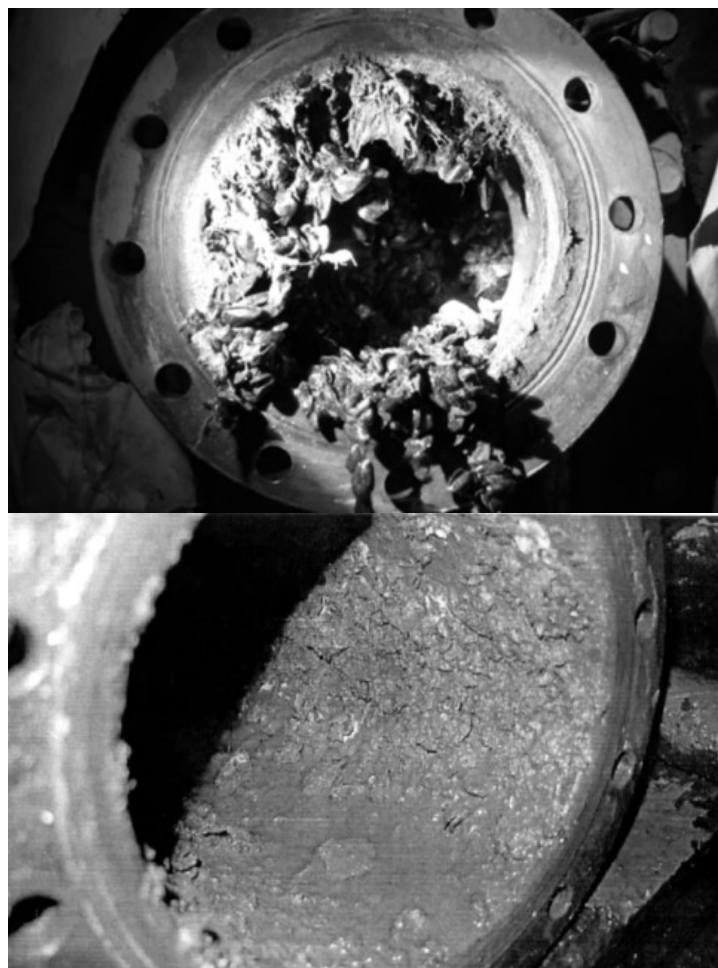


**Figure 2.** Pipeline condition before cleaning

#### **4. Cleaning Scheme**

The main engine of high pressure water jet is located at the bottom of the dock. Connect the main inlet pipe, the main power supply and the high-pressure hose of the outlet water. Lead the high-pressure hose to the cabin where the pipeline is to be cleaned. Install manual control valve and peristaltic nozzle. The sewage drainage tee is installed in the pipeline cleaning section, and the sewage collection bag is placed under the drainage tee. The outlet of the drainage tee is introduced into the filter entrance of the sewage collection bag. The sewage collection bag outlet is connected with the sewage pump inlet, and the sewage pipe is connected with the pump outlet [7]. Connect the sewage pump power supply, and lead the sewage pipe to the designated drainage point. The collected bags are separated by filters and the

collected marine waste is sent to the sewage tank in the dock manually. Prepare pipeline detectors and record video files as needed.

Open the intake valve and supply water to the main engine. Open the power switch, supply power to the main engine, supply power to the sewage pump, install sewage drainage tees and sewage collection bags at the entrance of the pipeline to be cleaned, and send the peristaltic nozzle to the entrance of the pipeline to be cleaned for 15-20 cm. Start the manual control valve and start cleaning the pipeline. Driven by the reaction force of the water jet, the squirming nozzle automatically spirals along the inner wall of the pipeline, and can manually control the forward speed according to the oyster and fouling thickness attached to the inner wall of the pipeline. Wastewater generated by cleaning is filtered and returned to the sewage collection bag, and the sewage pump is activated immediately, and the filtered sewage is transported to the designated place. When the pipeline is flushed, the sewage is discharged backwards into the sewage collection bag. Marine debris and other wastes are collected by non-woven collection bags. High-pressure water jet has great impact damage ability and can compress, shear and tear the body.

Close the manual control valve and shut down the high-pressure pump after cleaning. After the sewage is transported, the sewage pump is shut down, the power supply of the main engine is shut down, and the inlet valve is closed. Manual control valves are controlled for exhaust, drain tees and water pipes are disassembled, and high-pressure hoses are wound back to the pipe wheel. Clean up the filters, collect and fold the sewage collection bags, and disconnect the power supply after the pipeline detector is used. Carefully retrieve the camera from the detection area, clean the cable and camera, and return it to the coil rack, then disconnect all the connecting wires, and install the protective cover back to the connecting joint.

After the pipeline cleaning is completed, there are no residual marine organisms or other dirt on the cleaning surface, and there are no oxides, dirt, grease and other pollutants on the inner and outer surfaces. No surface defects such as thinning of pipe wall, scratches and pits caused by cleaning were found, as shown in Fig.3.

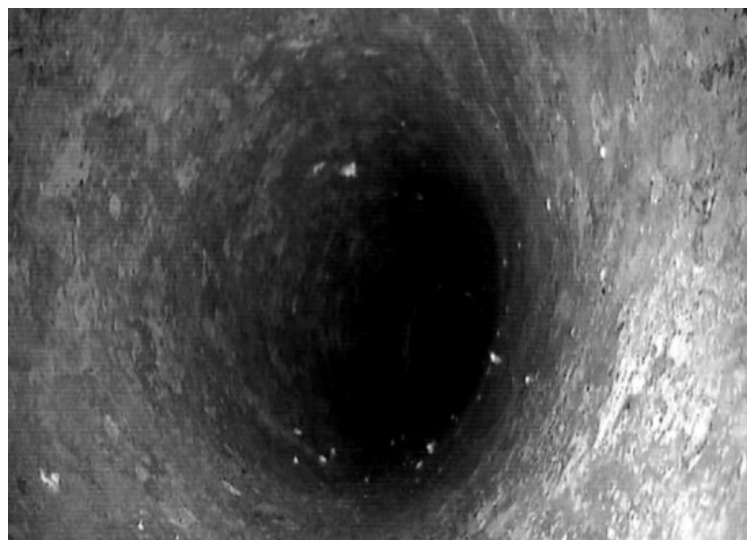


**Figure 3.** Pipeline condition after cleaning

## 5. Conclusion

High-pressure water jet cleaning technology is used to clean the polluted and blocked sea water pipelines, which can remove the marine organisms and other pollutants attached to the pipelines. After cleaning, there are no residual marine organisms or other dirt on the surface of the pipeline, and no surface defects such as thinning, scratches and pits caused by cleaning are found. High pressure water jet cleaning technology is an effective and reliable seawater pipeline cleaning technology.

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### References

- [1] B. Gelloz. Specific Blue Light Emission from Nanocrystalline Porous Si Treated by High-Pressure Water Vapor Annealing. *Japanese Journal of Applied Physics*, 2014, p.102-108.
- [2] C.M. Ikeda, J. Wilkerling. The implosion of cylindrical shell structures in a high-pressure water environment. *Proceedings Mathematical Physical & Engineering Sciences*, 2013, p.201-206.
- [3] I.G. Anghel. Post-dryout heat transfer to high-pressure water flowing upward in vertical channels with various flow obstacles. *International Journal of Heat & Mass Transfer*, 2012, p.8020-8031.
- [4] S. Liu, X. Liu. Rock breaking performance of a pick assisted by high-pressure water jet under different configuration modes. *Chinese Journal of Mechanical Engineering*, 2015, p.607-617.
- [5] H.X. Huang. Fiber orientation propelled by high-pressure water penetration in water-assisted injection molded fiber-reinforced thermoplastics part. *Journal of Composite Materials*, 2013, p.183-190.
- [6] Z. Huang Z. High-pressure water injection tests on permeability of deep rock mass under tunnels. *Chinese Journal of Geotechnical Engineering*, 2014, p.1535-1543.
- [7] G.L. Yang. Simulation of flow field of high-pressure water-jet from nozzle with FLUENT. *Journal of Lanzhou University of Technology*, 2008, p.10-18.