

## Longer lifetime for velocity and concentration sensors

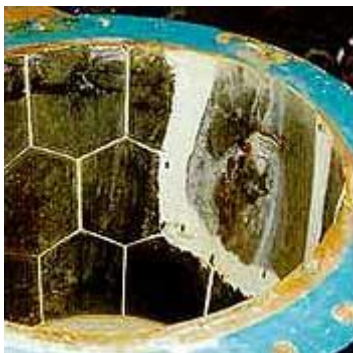
### Introduction

Ruling the dredging process requires exact knowledge of the concentration and velocity of the dredged mixture. Only then do we know what is going on in the pipes: if velocity is high, wear will be so too, but if velocity is too low, the mixture's solids will settle and clog the pipe. If concentration is low, production will be low as well. Since the amount of solids transported is a function of velocity and concentration of the mixture, both measures serve as check on the works progress. Clearly, dependably measuring velocity and concentration of the mixture is essential for the dredging efficiency. The challenge is to make transducers that stand the punishment of scouring mixtures for a sufficiently long time to be economically useful.



### Biters and boulders

In dredging, velocity and concentration of the mixture are mainly measured by sensors in the pipeline, in direct contact with the mixture. For obvious reasons these sensors are clad with scour resistant synthetic or ceramic liners. These must be non electricity conducting in order not to interfere with magnetic inductive velocity measuring. The liner of choice depends on the spoil to be transported: soft, impact dampening liners are used when silt, sand and gravel are pumped through; hard liners are better against sharp and coarse material. The problem gets a different dimension, however, when we realize that the dredged mixture rarely sticks to the rules: amidst the sand and gravel, sharp stones may swim that cut away the soft liner, while the impact of the odd boulder may crack the liners awaiting small sharp stones. This shortens the service time of sensors drastically, and often inspires operators to leave the sensors out entirely much to the detriment of the dredging process's efficiency. When unease in the market about the sensors' short lifetime and high costs of repair dawned, IHC Holland began researching possibilities of prolonging the lifetime of sensors and making repairs easier. Analyses of the problem learned that liners have to stand up to a number of threats: those that result from hydraulic transport the scouring character of any sand/water mixture rushing past and the impact of large particles and those that are the result of wrong treatment. As suggested before, soft liners of natural rubber or synthetic material suffer most from abrasive erosion, hard liners from impact erosion.



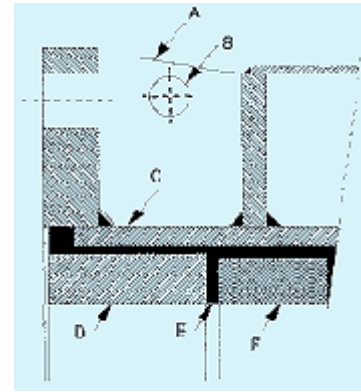
### Spoil scoures what sticks out

Many problems come from unhelpful users' practices. They are mainly caused by either the use of a new sensor in a pipe with larger pipe diameter -which often is caused by wear; or by distortion of the intermediate pipe that contains the sensor. If, for instance, the intermediate piece of pipe does just not fit, which is then compensated by turning on the bolts tighter, distortions in the pipe result. In pipes with ceramic liners the tiles tend to break under the bending strains of the said distortions, which especially occurs in thin walled pipes.

A difference in pipe thickness usually creates a butt. The same occurs if two pipes are not fitted quite straight on one another. In a combination of an old and a new pipe, the (narrower) new one will always wear most.

### Stiffer and stronger

These sources of problems have, after comprehensive research into the matter, led to a number of improvements on the transmitter tubes, so as to stop them being the weakest points in pipes: the liner is made of highly scour resistant, tough aluminium oxide tiles, which are made smaller and thicker than before, to further reduce the chances of breaking (F); the ceramic tiles are embedded in a strong irathane layer, which also fills the seams (E); on both sides the ceramic liner has got a steel capping ring, which bears the brunt of impact erosion (D); the stainless steel inner tube of the velocity meter has been made thicker, to increase stiffness and avoid the breaking of ceramic tiles (C); by making the pipe's wall thicker and extending the knees (with holes (B) to facilitate handling) to rigidly fix the flange and the sensor's housing, stiffness is greatly improved (A).



Below you'll find an account of the research project that made us better understand the process of wear and tear in sensors.

### Easier to repair

If liners were brought in for repair, the remaining material was usually burnt out, which was an expensive way of harming the environment. By using separate electrode connection rooms, the troublesome parts of the liner can now be jetted out while the rest is kept in place. The electrodes, pressed into the liner previously, have also ceased to be sources of leakage, because they now have their own, separate, pot. As a result, the sensor has become less susceptible to damage while repair has become cheaper. To investigate whether it all worked, dredging companies were glad to oblige, and operational tests have been carried out in the cutter dredger Taurus of Boskalis, the trailing suction hopperdredger City of London of U.M.A. and the hopperdredger Delta Queen of Blankevoort.

In the Taurus tests, a number of test pipes were fitted in the 850 mm discharge pipe: one was a newly designed velocity meter, with aluminium oxide tiles and the highest quality cast steel capping rings, while other test pipes had liners of cast basalt, irathane and a combination of aluminium oxide embedded in irathane. After dredging approximately 1/2 million m<sup>3</sup> caprock, calcerite, limestone and sand, all liners were worn out, except the aluminium oxide one, which still looked like new even the odd cracked tile was still in place, thanks to perfect glueing. Far over 4 million m<sup>3</sup> solids have passed the liner, but there is still no measurable wear.



Tests in the horizontal 700 mm diameter pipe of City of London confirmed these results, though after suffering 90,000 tonnes gravel and 150,000 tonnes of sand, the capping rings were noticeably worn. A new intermediate pipe with sensor had been fitted in an old pipe, and this was so badly worn that a butt developed, which harmed the capping rings.

Ultrasonic measuring of the tiles' thickness, indicated that the tiles near the bottom had worn most, especially upstream, while those in the top of the pipe had barely been touched. As expected, tests in the 900 mm diameter vertical pipe of Blankevoort's hopperdredger Delta Queen, revealed an even, all round wearing pattern, which is typical of vertical pipes.

The operational tests confirm that aluminium oxide is by far the best material for liners to be used in various circumstances and for a variety of dredged materials.

### **Wear in the laboratory**

To further scrutinise the results, experiments have been carried out in the sludge trial stands of MTI Holland and TNO. In the last test, also the effects of flowing angles have been investigated. The test apparatus' main parts are two disks, pivoting in opposite directions, with two holders for cylindrically shaped experimental material each one holding as reference material steel C22, the other either irathaan 82, shore AIO<sub>92</sub> (aluminium oxide), abresist (cast basalt) or HDP (high density polyethylene), as had also been operationally tested. During the experiments, both disks were completely immersed in a sand/water mixture of 1330 kg/m<sup>3</sup>, with coarse sand (700 µm). The average wear was found by weight measurement: In volume wear per mm<sup>3</sup>, irathane suffered remarkably little wear: in other words, it is virtually not affected by the flowing angle. Aluminium oxide was quite good also, cast basalt did badly. In operational tests with coarse and sharp material, aluminium oxide was significantly better than irathane.

### **Drop proof**

When dredging coarse material, big boulders might hit the pipe's wall and it was deemed useful to know what the aluminium oxide tiles could bear before bursting. A test was developed which could also help in comparing the quality of various parties of tiles. A reference measuring experiment was set up to compare different materials as well as testing the quality of tiles. In the experiment, the tiles were subjected to a dropping object, the weight and height of which could be varied. The results were registered and measured by acceleration meter and suitable software. Maximum strength, fatigue and strength of tiles under impact at the rim were investigated. The experiments clearly proved that being glued in vastly improved the aluminium oxide tiles' impact resistance.



The glueing of the tiles was tested extensively, mainly to establish the best methods for: bringing on the centrifugal moulded basic layer; the glueing of the tiles on this layer; the centrifugal casting of the seams; and the positioning of the steel capping rings. For the benefit of ultrasound measurements on board, the speed of sound spectrum of the ceramic material was also investigated, as was the Gamma absorption. The low specific density gives the aluminium oxide tiles a gamma absorption far lower than that of the alternative thicker steel pipe walls, and thus allows the use of a far smaller radioactive source, or a larger diameter pipe while staying within an acceptable radiation output of the source.

### **Conclusion**

The experiments have resulted in a number of modifications in the sensors. Characteristics of the modernized sensor: glued wear resistant ceramic liner based on aluminium oxide, protected on both sides with steel capping rings; a stronger and stiffer construction which takes the strain from the ceramic tiles; a modified electrode construction minimising the risk of leakage near the electrodes; a separate housing for the electrode to trap any unlikely leakage and keep it out of the coil chamber. These modifications have significantly improved the product's endurance and brought repair costs dramatically down. The research was carried out by: IHC SYSTEMS, IHC HOLLAND, IHC LAGERSMIT and KROHNE ALTOMETER, and the research laboratories of MTI HOLLAND and TNO.

(Source : *Ports & Dredging* nr. 145 from 1995)