Case CO_2 // Energy
Energy savings using fluoroplastic coated tubes

By Christian Strøbech and Jens Hinke

Contact (at DuPont ®): Jürgen Hofmann, DuPont ®
Phone direct: 0032474891626
Mail: jurgen.hofmans@bel.dupont.com

Technical data

Tubes:	Steel and stainless steel
Length:	6 -12 metres
Diameters:	Ø 100 – Ø 250 mm
Coatings:	StreaMax™ three layer coating, primer, mid-coat and top-coat
Process:	Heat-treatment 400°C, sandblasting, coating, sintering, control
Total film thickness:	115 – 125 my

From DuPont® has been received the following pressure drops when using non-coated tubes and StreaMax™ coated tubes:

Table 1. Friction drop data for coated, clean new pipe and lightly rusted pipe

Theoretical Frictional Pressure Drop
8 500 m³/day water flow, 9 000 m length
68 °C, density = 975.6 kg/m³ viscosity = 4.198e-4 Pa-s

	StreaMax™				Clean New Pipe				Lightly Rusted Pipe	
Rough-ness, in	Perfectly smooth		0.0001		0.001		0.0018		0.01	
Inside Dia in	6.184	6.785	6.184	6.765	6.184	6.765	6.184	6.765	6.184	6.765
Press Drop, bar	76	49	80	51	100	63	110	70	161	100

Calculated using the Churchill equation for Fanning friction factor in terms of roughness ε, inside diameter D, and Reynolds number Re.

$$\frac{1}{\sqrt{f}} = -4\log_{10}\left[\frac{0.27\varepsilon}{D} + \left(\frac{7}{\mathrm{Re}}\right)^{0.9}\right]$$

JT April 2, 2008

Taken as an example a StreaMax™ tube with an inside diameter of 6.184 inches and roughness of 0.0001 inches and compare it with a lightly rusted pipe with the same diameter and a roughness of 0.01 inches, then the question is how much energy it takes to move 8.500 m^3 water/day when the pump has to work against a pressure of 80 bar.

We know that 10 meter water column is app. 1 bar. 80 bar is therefore 800 meter water column.

The potential energy is: E = m x G x h M in m^3 , G= 9.81 m/sec^2, h = height in meter
E = 8.500 x 1.000 x 9.81 x 800 kg x m/sec^2 x m = joule
E = 667 x 10^8 joules per day
E = 667 x 10^8/24 x 60 x 60 = 7.700 kW

If the energy similarly is calculated for the 2 diameters with StreaMax™ and for the lightly rusted pipe, the following results are obtained:

Table 2. Savings using a StreaMax™ coated pipe in stead of a lightly rusted pipe

Tube diameter	StreaMax™ 0.001	Light rusty	Savings	Pump-savings 50% effective	CO_2 savings
6.184 inches	7.700 kW	15.500 kW	7.800 kW	15.600 kW	7.706 kg
6.765 inches	4.900 kW	9.600 kW	4.700 kW	9.400 kW	4.644 kg

The savings for 6.184 inch tube is 7.800 kW, but if we assume, the pump has an efficiency of 50% then the actual saving is 15.600 kW.

Producing 1.000 kWh produces in Denmark 494 kg CO_2. This means the environment is saved for the amount of CO_2 mentioned in Table 2.

In Denmark 1 kWh for industrial purposes cost about 1 Danish “krone”. This means that the coated 6.184 pipe saves the user DKK 15.600 per hour or 374.400 DKK per day for moving the water 8.500 m^3/day over a length of 9.000 meter. The environment is saved for 7.706 kg each hour or 24 x 7706 = 184.944 kg a day.

Accoat's use of energy to coat the StreaMax™ tubes

The process for coating the tubes may be seen in Table 3 below.

The coating parameters are controlled by using temperature loggers, meters on the natural gas supply etc. Normally several tubes often of different diameters are heat treated, coated, dried and sintered at the same time in the same oven. The example given in table 3 is therefore a typical example:

Table 3. The coating process for StreaMax™ tubes.

Process/product	Number of tubes	Length of tubes	Gas in m^3	CO_2 kg emission	Price DKK	Man-hours
Heat treatment	12	12 m	402	906	3.284	6?
Sandblasting	12	12 m				12?
Special sand	12	12 m			?	
Primer	6	Various	695	1.566	5.678	6?
Mid-coat	6	Various	363	818	2.965	6?
Top-coat	6	Various	275	620	2.247	6?
Total			1.735	3.917	14.174	
Total gas for 1 piece of a 12 m tube			289	653	2.362	
Total for 1 m tube			24	54.4	196.8	
Total per 9.000 m tubes			216.000	489.600	1.768.000	

Price of gas: DKK 8.17
Each 1.000 m^3 natural gas emits: 2.253 kg CO_2
One man-hour corresponds to: 1.14 kg CO_2

Above it was found, that the customer saves DKK 374.400 per day transporting water 8.500 metres per day a length of 9.000 metres.

This means, that the pay-back time for the 9.500 metres of 6.184 tube is:

Pay-back time: Customers price / 374.400 = x days

"Pay-back time" for CO_2 based on gas consumption 489.600 / 184.944 = 2.6 days

Note: The above example is based on a test production at Munkegårdsvej 16, and it only takes into account the amount of gas used, not the cost of man-power, sand for sandblasting and cost of equipment. When the new production plant is operating a more accurate calculation can be made.

Conclusion

Accoat is coating the inside of tubes for the oil- and gas industry in order to prevent corrosion and for reducing the friction inside the tubes. Energy savings using coated versus non-coated tubes can be calculated based on the changes in pressure drop. Likewise, reduction in CO_2 emissions to the environment can be calculated. The amount of CO_2 emitted by Accoat is very small compared with what is saved by the oil company. It can be calculated that the CO_2 pay-back time is about 9.6 days.

References

1. DuPont® StreaMax™ Coating *"Flow Solutions For the oil & gas industry".*
2. Powered by science: DuPont® StreaMax™. Pages on the internet when searching on StreaMax™.