Energy Savings Using StreaMax™-coated Tubes

a report by

Christian Strøbech[1] *and* **Jens Hinke**[2]

1. Scientist, Research and Development, Accoat; 2. Director, Research and Development, SP Group

Accoat coats 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 2.6 days (see *Table 1*).

Table 2 lists the pressure drops received from DuPont® when using non-coated tubes and StreaMax-coated tubes. As an example, take 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; the question is how much energy it takes to move 8,500m^3 water/day when the pump has to work against a pressure of 80 bar.

We know that a 10m water column is approximately 1 bar; 80 bar is therefore an 800m water column. The potential energy is:

- E = m x G x h M in m^3, G= 9.81m/sec^2, h = height in metres;
- E = 8.500 x 1.000 x 9.81 x 800kg x m/sec^2 x m = Joules;
- E = 667 x 10^8 Joules; and
- E = 667 x 10^8/24 x 60 x 60 = 7,700kW.

Table 3 shows the results obtained if the energy is similarly calculated for the two diameters with StreaMax and for the lightly rusted pipe.

Christian Strøbech works at Accoat, developing fluoroplastic coatings and being active in quality and environmental matters. He has has written several articles on printing inks, adhesives, polyurethanes and coatings based on fluoroplastics. Previously, he was employed by Sadofoss, a member of the Sadolin Group, as laboratory manager developing adhesives based on polyurethane chemistry and technology, by Interchemical Corporation, IPI, New York, carrying out development work in novelty printing inks, alkyds and in the area of adhesion, and by the Danish Paint and Lacquer Factory (DFL), developing printing inks and the California Ink Company in Berkeley. Mr Strobech holds an MSc in chemistry and chemical engineering.

E: nsl@accoat.dk

Jens Hinke is Research and Development Director at the internationally famous SP Group, of which Accoat is a subsidiary. Previously, he was Managing Director at Accoat. During the last 30 years, he has interacted with business partners, collaborators and customers to provide surface solutions in cases where no other company has been able to deliver; naturally, he will maintain this unique work with fluoroplastic coatings in the future. Mr Hinke holds an MSc in chemistry from the Danish Technical University.

Table 1: CO_2 Case – Data, Measurement and Analysis

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

Figure 1: Tubes Internally Coated with DuPont StreaMax™ Ready for Shipment

Figure 2: Tube Internally Coated with DuPont StreaMax™ Coating System

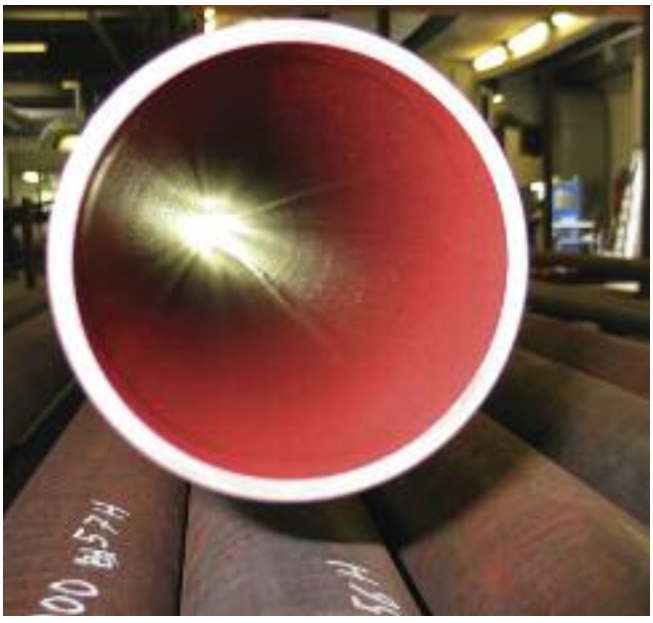

Table 2: Friction Drop Data for Coated, Clean New Pipe and Lightly Rusted Pipe

Theoretical friction pressure drop 8,500m³/day water flow, 9,000m length, 68°C, density = 975.6kg/m³ viscosity = 4.198e^{-4} Pa^{-s}

	StreaMax™				Clean New Pipe				Lightly Rusted Pipe	
Roughness, inches	Perfectly smooth		0.0001		0.001		0,0018		0.01	
Inside diameter, inches	6.184	6.785	6.184	6.765	6.184	6.765	6.84	6.765	6.184	6.765
Pressure 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 E, inside diameter D, and Reynolds number Re.

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

Table 3: Savings Using a StreaMax-coated Pipe Instead of a Lightly Rusted Pipe

Tube Diameter (inches)	StreaMax 0.001 (kW)	Lightly Rusted (kW)	Savings (kW)	Pump Savings 50% Effective (kW)	CO_2 Savings (kg)
6.184	7,700	15,500	7,800	15,600	7,706
6.765	4,900	9,600	4,700	9,400	4,644

Table 4: The Coating Process for StreaMax Tubes

Process/Product	Number of Tubes	Length of Tubes (m)	Gas (m³)	CO_2 emission (kg)	Price (DKK)	Man-hours
Heat treatment	12	12m	402	906	3.284	6
Sandblasting	12	12m				12
Special sand	12	12m				
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 one piece of a 12m tube			289	653	2.362	
Total for 1m tube			24	54.4	196.8	
Total per 9,000m tubes			216,000	489,600	1,768,000	

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

In Denmark, producing 1,000kWh generates 494kg CO_2. This means the environment is saved the amount of CO_2 mentioned in *Table 2*.

In Denmark, for industrial purposes 1kWh costs about 1 Danish krone (DKK). This means that the coated 6.184-inch pipe saves the user DKK15.600 per hour or DKK 374.400 per day for moving the water 8.500m³/day over a length of 9,000m. The environment is for 7.706kg each hour or 24 x 7706 = 184.944kg a day.

Accoat's Use of Energy to Coat the StreaMax Tubes

The process for coating the tubes is outlined in *Table 4*. The coating parameters are controlled 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 4 is therefore typical. The pay-back time for the 9,500m of 6.184-inch tube is calculated as customer's price/374.400 = x days, so in this example pay-back time for CO2 based on gas consumption is 489.600/184.944 = 2.6 days.

It should be noted that the above example is based on test production at Munkegårdsvej 16, and only takes into account the amount of gas used, not the cost of manpower, sand for sandblasting and equipment. When the new production plant is operating, a more accurate calculation can be made. ■

1. DuPont® StreaMaxTM Coating, 'Flow Solutions for the Oil & Gas Industry'.

Contact information

Accoat A/S
Munkegaardsvej 16
DK-3490 Kvistgaard
Denmark

Tel: + 45 49 12 68 00, Fax: + 45 49 12 68 99
E: info@accoat.dk, www.accoat.com