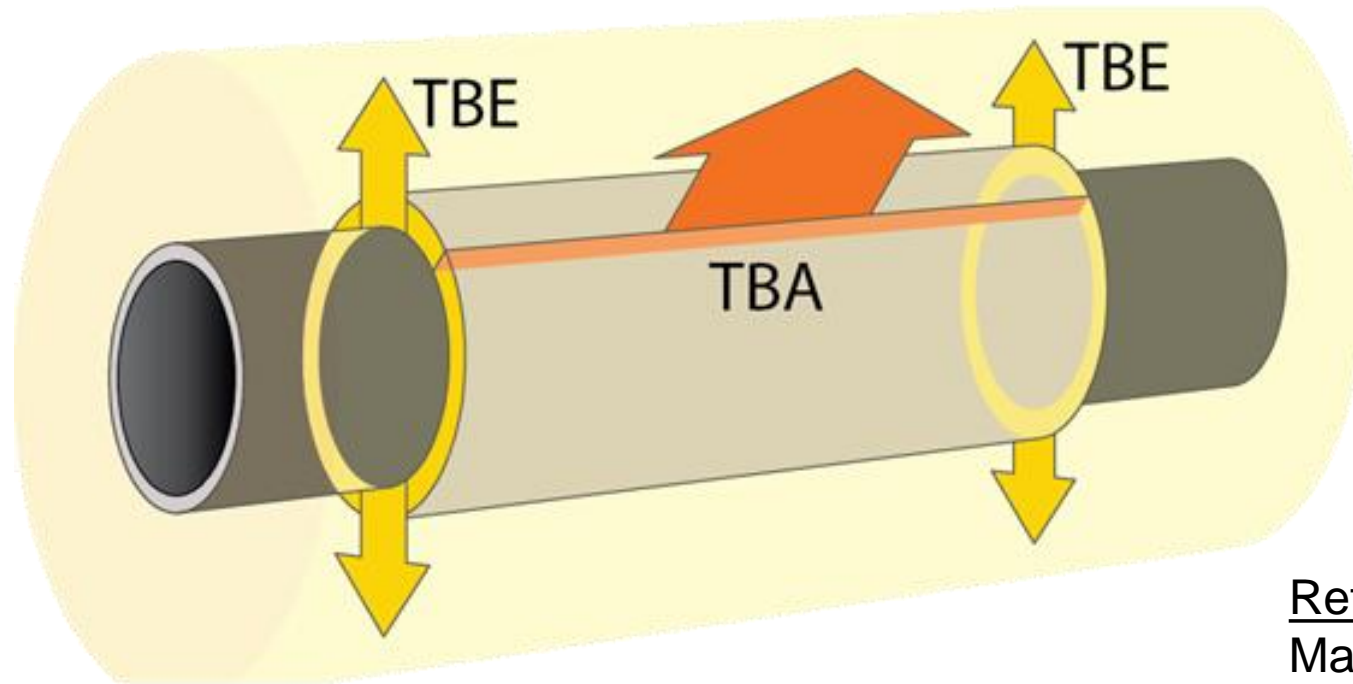


LIVSLÄNGD HOS HYBRIDISOLERADE FJÄRRVÄRMERÖR



Reference group:

Magnus Ohlsson Öresundskraft

Zayed Azobidie E.ON Energilösningar AB

Shahriar Badiei Vattenfall

Beviljad budget: 567000 kr

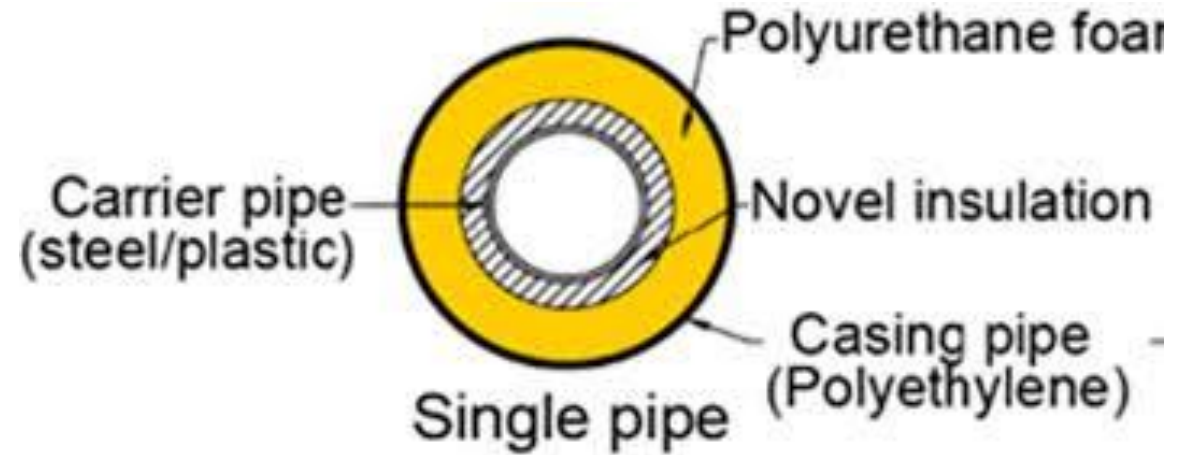
projektid: augusti 2020-Mars 2021

Project leader: Bijan Adl-Zarrabi

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Background: 2011-2020

Cylindrical Vacuum panel



Declared thermal conductivity 0.005 W/mK
About **5-6 times** better than PUR

POWERPIPE

**RI.
SE**

Conclusions:

- 40-45% better thermal performance for a single pipe
- 35-40% better thermal performance for a twin pipe
- The performance of the hybrid insulated pipes will **always** be better than ordinary insulated pipe.

LIVSLÄNGD OCH STATUSBEDÖMNING AV FJÄRRVÄRMENÄT
 RAPPORT 2017-420

HÖGPRESTERANDE FJÄRRVÄRMERÖR
 RAPPORT 201316

LIVSLÄNGD FÖR HYBRIDISOLERADE FJÄRRVÄRMERÖR
 RAPPORT 201322

HYBRIDISOLERADE FJÄRRVÄRMERÖR
 RAPPORT 201323

Figure 10 shows the temperature distribution over the casing and the insulated heat conductivity is shown at each distance.

| Distance (mm) | Temperature (°C) | Heat conductivity (W/mK) |
|---------------|------------------|--------------------------|
| 0 | 25.82 | 24.7 |
| 10 | 25.22 | 25.9 |
| 20 | 23.49 | 24.7 |
| 30 | 22.34 | 24.7 |
| 40 | 21.74 | 24.7 |
| 50 | 21.17 | 24.7 |
| 60 | 20.61 | 24.7 |
| 70 | 20.04 | 24.7 |
| 80 | 19.47 | 24.7 |
| 90 | 18.90 | 24.7 |
| 100 | 18.33 | 24.7 |
| 110 | 17.76 | 24.7 |
| 120 | 17.19 | 24.7 |
| 130 | 16.62 | 24.7 |
| 140 | 16.05 | 24.7 |
| 150 | 15.48 | 24.7 |
| 160 | 14.91 | 24.7 |
| 170 | 14.34 | 24.7 |
| 180 | 13.77 | 24.7 |
| 190 | 13.20 | 24.7 |
| 200 | 12.63 | 24.7 |
| 210 | 12.06 | 24.7 |
| 220 | 11.49 | 24.7 |
| 230 | 10.92 | 24.7 |
| 240 | 10.35 | 24.7 |
| 250 | 9.78 | 24.7 |
| 260 | 9.21 | 24.7 |
| 270 | 8.64 | 24.7 |
| 280 | 8.07 | 24.7 |
| 290 | 7.50 | 24.7 |
| 300 | 6.93 | 24.7 |
| 310 | 6.36 | 24.7 |
| 320 | 5.79 | 24.7 |
| 330 | 5.22 | 24.7 |
| 340 | 4.65 | 24.7 |
| 350 | 4.08 | 24.7 |
| 360 | 3.51 | 24.7 |
| 370 | 2.94 | 24.7 |
| 380 | 2.37 | 24.7 |
| 390 | 1.80 | 24.7 |
| 400 | 1.23 | 24.7 |
| 410 | 0.66 | 24.7 |
| 420 | 0.09 | 24.7 |
| 430 | -0.48 | 24.7 |
| 440 | -1.05 | 24.7 |
| 450 | -1.62 | 24.7 |
| 460 | -2.19 | 24.7 |
| 470 | -2.76 | 24.7 |
| 480 | -3.33 | 24.7 |
| 490 | -3.90 | 24.7 |
| 500 | -4.47 | 24.7 |
| 510 | -5.04 | 24.7 |
| 520 | -5.61 | 24.7 |
| 530 | -6.18 | 24.7 |
| 540 | -6.75 | 24.7 |
| 550 | -7.32 | 24.7 |
| 560 | -7.89 | 24.7 |
| 570 | -8.46 | 24.7 |
| 580 | -9.03 | 24.7 |
| 590 | -9.60 | 24.7 |
| 600 | -10.17 | 24.7 |
| 610 | -10.74 | 24.7 |
| 620 | -11.31 | 24.7 |
| 630 | -11.88 | 24.7 |
| 640 | -12.45 | 24.7 |
| 650 | -13.02 | 24.7 |
| 660 | -13.59 | 24.7 |
| 670 | -14.16 | 24.7 |
| 680 | -14.73 | 24.7 |
| 690 | -15.30 | 24.7 |
| 700 | -15.87 | 24.7 |
| 710 | -16.44 | 24.7 |
| 720 | -17.01 | 24.7 |
| 730 | -17.58 | 24.7 |
| 740 | -18.15 | 24.7 |
| 750 | -18.72 | 24.7 |
| 760 | -19.29 | 24.7 |
| 770 | -19.86 | 24.7 |
| 780 | -20.43 | 24.7 |
| 790 | -21.00 | 24.7 |
| 800 | -21.57 | 24.7 |
| 810 | -22.14 | 24.7 |
| 820 | -22.71 | 24.7 |
| 830 | -23.28 | 24.7 |
| 840 | -23.85 | 24.7 |
| 850 | -24.42 | 24.7 |
| 860 | -24.99 | 24.7 |
| 870 | -25.56 | 24.7 |
| 880 | -26.13 | 24.7 |
| 890 | -26.70 | 24.7 |
| 900 | -27.27 | 24.7 |
| 910 | -27.84 | 24.7 |
| 920 | -28.41 | 24.7 |
| 930 | -28.98 | 24.7 |
| 940 | -29.55 | 24.7 |
| 950 | -30.12 | 24.7 |
| 960 | -30.69 | 24.7 |
| 970 | -31.26 | 24.7 |
| 980 | -31.83 | 24.7 |
| 990 | -32.40 | 24.7 |
| 1000 | -32.97 | 24.7 |

- A hybrid insulated pipe by vacuum panels fulfil the technical demands. However, the cost of the vacuum panel is about 10 times more than polyurethan insulation per cubic meter.

Considering **3** times better thermal performance of the VIP in comparison, still VIP has a price which is about 3,3 times more than polyurethan.

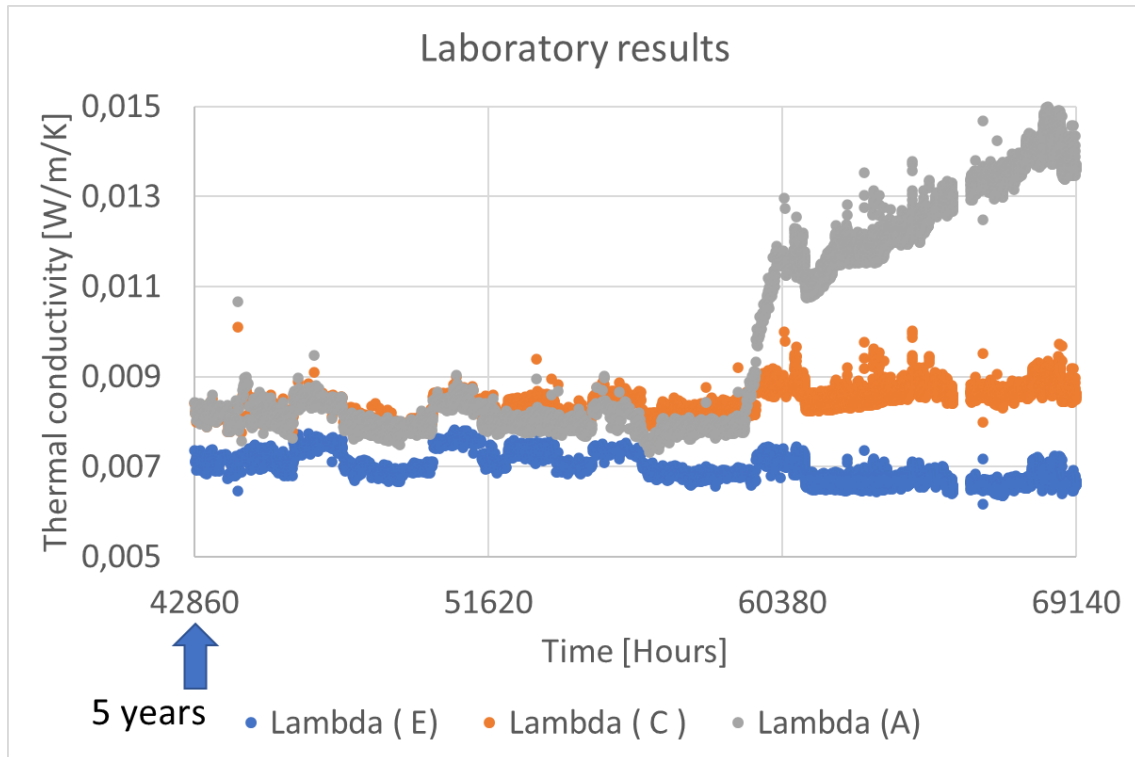
The aim of ongoing project is the calculation of payoff time for hybrid insulated pipes.

Payoff time is a function several parameters among them; the lifetime of the vacuum panels and the cost off energy.

Lifetime / Laboratory

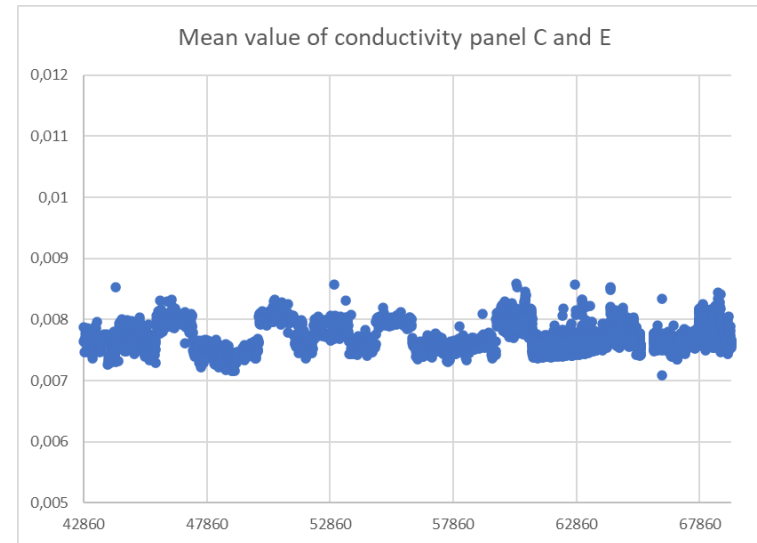
Condition:

- Supply pipe temperature 115 °C, 8 years



Conclusions 1 : (based on panel A)

- The lifetime of panels is at least 7 years at 115 °C, with expected performance (3 times better than PUR) And the rest of the time (up to 50 years) at least 1.8 times (15 mW/mK) better than PUR.



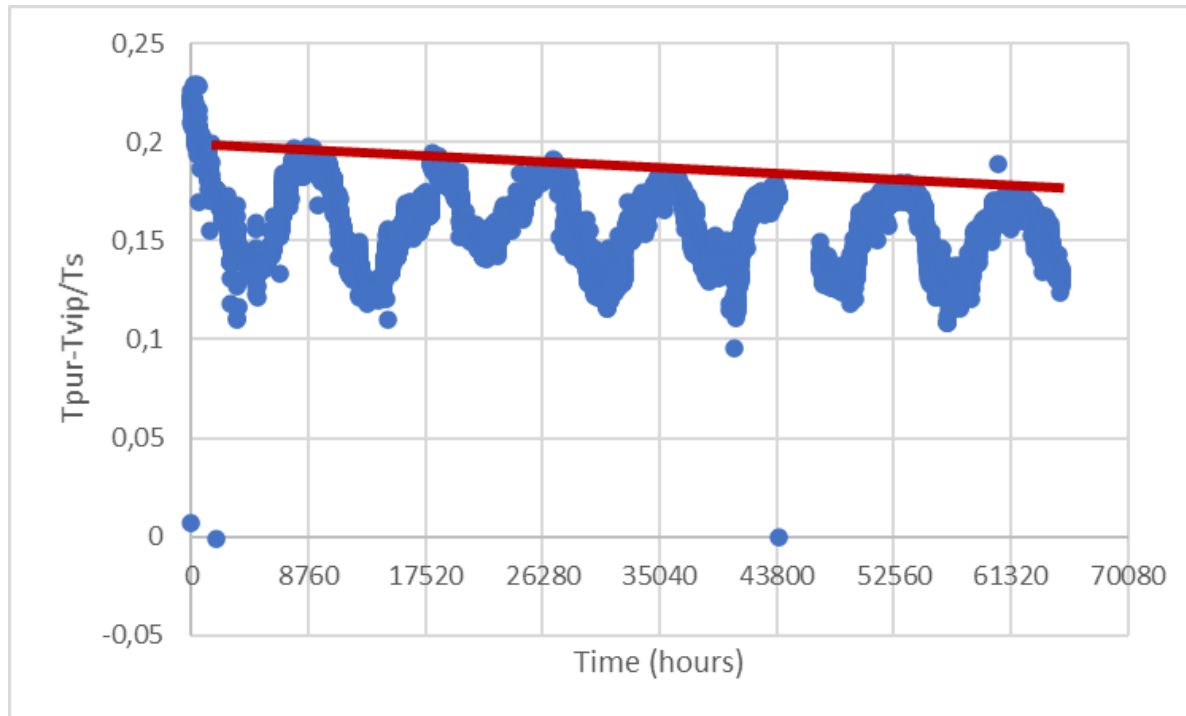
Conclusion 2: (based on panel B and C)

- No measurable degradation during first 7-8 years

Lifetime / Field station-Varberg

Condition:

- Supply pipe temperature 90 °C,
- Return pipe 60 ° C
- Duration 8 years



Conclusions 3 : (based on field station)

- The panels degrade by 1,0% per year.

The expected lifetime with assumption that panels will be 1.8 (15 mW/mK) times better than PUR is 64 years.

The panels reach a thermal performance as PUR after mor than 150 year

Payoff time for a twin pipe DN 2x80/280

| | Energy price [Öre/kWh] | | | |
|------------------------|------------------------|------|------|------------------------|
| | 50 | 30 | 20 | Produktion line [%] |
| Payoff time [years] | 5,5 | 9,1 | 13,6 | 100 |
| | 8,2 | 13,6 | 20,4 | 50 |

Payoff time for a single pipe DN80/180, considering 10 and 20% reduction of the price of VIP.

A reduction of production line by 50% is considered.

| | Energy price [Öre/kWh] | | | |
|----------------------------|------------------------|-----|------|-------------------------|
| | 50 | 30 | 20 | VIP-price reduction [%] |
| Payoff time [years] | 4,2 | 6,9 | 10,4 | 0 |
| | 3,8 | 6,5 | 9,7 | 10 |
| | 3,6 | 6 | 9 | 20 |

Other parameters which should be added:

- Advantages which is difficult to add in payoff model:
 - prolonged lifetime of PUR
 - lower heat demand helps to increase electricity generation in heat and power plants.
 - lower Co2 emissions

**Thanks for your attention.
Question/comments**