Test of Energy Catalyzer

Bologna October 6, 2011

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The E-cat model used in this test was enclosed in a casing measuring about 50 x 60 x 35 centimeters. As in previous tests heat was supposedly generated inside a reactor by a reaction between nickel powder and pressurized hydrogen in presence of unknown catalysts.

Water was fed into the E-cat from a peristaltic pump and heated to boiling temperature. The steam at the output from the E-cat was fed through an insulated hose to a heat exchanger (SWEP E8T-SC-S) where it was cooled down and condensed while heating a secondary circuit of water. The cool water from condensed steam was led through a hose down the drain.

Water from a tap was fed to the secondary loop of the heat exchanger. The heated output water was led through a long hose to a well outside the building.

Water temperature at the input and the output of the secondary loop was measured with thermocouples attached on the metal connections at the heat exchanger where the hoses were attached (see video) and the difference in temperature was used together with the value of the water flow to calculate the output power.

To start up the reaction and reach equilibrium, electric power was fed to a resistance inside the E-cat for about four hours, interrupted only by short intervals of self sustained mode.

The E-cat was then put in self sustained mode for almost four hours, showing no measurable signs of weakening.

After three hours and a half, output temperature inside the E-cat was stable about 114 degrees centigrade, and water could be felt boiling putting a hand on top of it. The external temperature was between 60 and 85 degrees centigrade.

At the end of the test, the heat production was slowed down by eliminating hydrogen pressure and increasing the water flow from the peristaltic pump through the E-cat.

After cooling down the E-cat, the insulation was eliminated and the casing was opened. Inside the casing metal flanges of a heat exchanger could be seen, an object measuring about 30 x 30 x 30 centimeters. The rest of the volume was empty space where water could be heated, entering through a valve at the bottom, and with a valve at the top where steam could come out.

Inside the heat exchanger there supposedly was a layer of about 5 centimeters of shielding, and inside the shielding the reactor body, supposedly measuring 20 x 20 x 1 centimeters and containing three reactor chambers.

According to Andrea Rossi, only one of the reactors was in operation during the test.

Observations:

Weighing:

Weight of E-cat	before test: 98 kg
	after test: 99 kg
Weight of heat exchanger	before test: 10.208 kg
	after test: 10.265 kg

Hydrogen was filled after having checked that there was no pressure inside the E-cat. The bottle was attached, opened, closed, and detached.

Weight hydrogen bottle:

- before filling:	13606.4 grams
- after filling:	13604.9 grams
Total loaded:	1.5 grams

Pressure H2 Bottle: 55 bar Reduced: 15 bar

Temperature:

Room temperature was between 28.7 °C and 30.3 °C.
T2 – temperature at output, inside the E-cat
T3 – water inlet temperature of E-cat

T_{in} – water temperature at inlet of heat exchanger
T_{out} – water temperature at output of heat exchanger

Calibration water flow, secondary circuit:

Water flow was started about 11:00.

Water was filled into a one liter measure, time was measured and the water weighed.
1035 g in 6.06 seconds gives 171 g/s.
1007 g in 5.97 seconds gives 169 g/s.
Similar measurements during the test confirmed these values

Using the flow meter attached to the heat exchanger the time for 10 liters was measured several times during the test and found to be between 58.1 and 54.4 seconds, giving a flow between 183 and 172 g/s.

The total flow from 11:57 until 19:03 was 4554.3 liters, giving an average flow of 178 g/s or 641 liters/h.

11:12 Control unit switched on.
Total AC current 142 mA. Over all AC voltage 229 V.
Note: All DC measurements were found to be zero during the test.

11:18 T_{in} = 25.3 °C T_{out} = 24.6 °C

11:22 T3 = 25.6 °C T2 = 29.9 °C

11:52 T_{in} = 24.7 °C T_{out} = 24.2 °C
T3 = 25.6 °C T2 = 29.7 °C

Power to the electric resistance was switched on and set to the value "5."

Overall current 8.07 A. Voltage 225 V.
Current through resistance 7.22 A.

12:02 Power was set to "6."
Overall current 9.22 A. Voltage 226 V.
Current through resistance 8.46 A.

12:12 Power was set to "7."
Overall current 10.27 A. Voltage 225 V.
Current through resistance 9.65 A.

T_{in} = 24.5 °C T_{out} = 24.0 °C
T3 = 25.7 °C T2 = 31.1 °C

12:22 Power was set to "8."
Overall current 11.24 A. Voltage 224 V.
Current through resistance 10.80 A.

T_{in} = 24.5 °C T_{out} = 24.0 °C
T3 = 25.7 °C T2 = 34.4 °C

12:32 Power was set to "9."
Overall current 12.05 A. Voltage 224 V.
Current through resistance 11.88 A.

T_{in} = 24.7 °C T_{out} = 24.2 °C
T3 = 25.7 °C T2 = 40.2 °C

12:52 T_{in} = 24.4 °C T_{out} = 23.6 °C
T3 = 25.7 °C T2 = 59.3 °C

13:02 T_{in} = 24.7 °C T_{out} = 23.9 °C
T3 = 25.8 °C T2 = 68.0 °C

13:14 Overall current 12.05 A. Voltage 224 V.
Current through resistance 11.84 A.

T_{in} = 24.4 °C T_{out} = 23.7 °C
T3 = 25.8 °C T2 = 77.8 °C

13:22 Overall current 12.06 A. Voltage 224 V.
Current through resistance 11.84 A.

T_{in} = 24.4 °C T_{out} = 23.7 °C
T3 = 25.8 °C T2 = 84.2 °C

13:38 T_{in} = 24.9 °C T_{out} = 26.3 °C
T3 = 25.8 °C T2 = 94.8 °C

13:41 T_{in} = 25.2 °C T_{out} = 27.2 °C
T3 = 25.0 °C T2 = 96.8 °C

13:48	T_{in} = 25.2 °C	T_{out} = 28.7 °C
	T3 = 25.0 °C	T2 = 101.5 °C
14:00	Power to the resistance was set to zero. Overall current 140 mA. Voltage 231 V. Current through resistance was zero, and voltage also zero.	
14:01	T_{in} = 26.0 °C	T_{out} = 32.9 °C
	T3 = 25.0 °C	T2 = 110.2 °C
14:10	Power was set to "9." Overall current 11.94 A. Voltage 222 V. Current through resistance 11.66 A.	
	T_{in} = 26.3 °C	T_{out} = 30.7 °C
	T3 = 25.1 °C	T2 = 115.2 °C
14:15	T_{in} = 26.0 °C	T_{out} = 29.9 °C
	T3 = 25.1 °C	T2 = 117.3 °C
14:20	Power was set to zero.	
	T_{in} = 26.4 °C	T_{out} = 30.7 °C
	T3 = 25.2 °C	T2 = 118.9 °C
14:30	T_{in} = 26.1 °C	T_{out} = 30.0 °C
	T3 = 25.3 °C	T2 = 121.6 °C
14:37	Power was set to "9." Overall current 11.89 A. Voltage 221 V. Current through resistance 11.57 A.	
	T_{in} = 26.3 °C	T_{out} = 30.1 °C
	T3 = 25.3 °C	T2 = 122.0 °C
14:46	T_{in} = 26.1 °C	T_{out} = 29.6 °C
	T3 = 25.3 °C	T2 = 121.6 °C
14:50	Power was set to zero.	
	T_{in} = 26.2 °C	T_{out} = 29.6 °C
	T3 = 25.4 °C	T2 = 121.2 °C
14:51	T_{in} = 26.3 °C	T_{out} = 30.2 °C
	T3 = 25.4 °C	T2 = 121.2 °C
14:59	Power was set to "9." Overall current 11.92 A. Voltage 220 V. Current through resistance 11.59 A.	
	T_{in} = 26.1 °C	T_{out} = 30.2 °C
	T3 = 25.4 °C	T2 = 120.9 °C
15:25	T_{in} = 26.2 °C	T_{out} = 31.0 °C
	T3 = 25.4 °C	T2 = 119.2 °C
15:42	T_{in} = 25.9 °C	T_{out} = 28.9 °C
	T3 = 25.5 °C	T2 = 121.8 °C
15:53	Power to the resistance was set to zero. A device "producing frequencies" was switched on.	

Overall current 432 mA. Voltage 230 V.
Current through resistance was zero, voltage also zero.
From this moment the E-cat ran in self sustained mode.

15:56	T_{in} = 24.9 °C	T_{out} = 33.4 °C
	T3 = 25.6 °C	T2 = 123.8 °C
16:13	T_{in} = 24.7 °C	T_{out} = 32.9 °C
	T3 = 25.6 °C	T2 = 121.7 °C

Overall current 432 mA. Voltage 229 V.
Current through resistance was zero, voltage also zero.

16:22	T_{in} = 24.9 °C	T_{out} = 31.7 °C
	T3 = 25.6 °C	T2 = 118.9 °C
16:38	T_{in} = 24.5 °C	T_{out} = 33.7 °C
	T3 = 25.7 °C	T2 = 115.4 °C

Overall current 544 mA. Voltage 230 V.
Current through resistance was zero, voltage also zero.

16:50	T_{in} = 24.7 °C	T_{out} = 35.5 °C
	T3 = 25.7 °C	T2 = 115.0 °C
17:08	T_{in} = 25.0 °C	T_{out} = 34.0 °C
	T3 = 25.8 °C	T2 = 114.8 °C
17:20	T_{in} = 24.7 °C	T_{out} = 31.3 °C
	T3 = 25.8 °C	T2 = 114.4 °C
17:33	T_{in} = 24.4 °C	T_{out} = 30.5 °C
	T3 = 25.9 °C	T2 = 114.3 °C
18:00	T_{in} = 24.4 °C	T_{out} = 31.6 °C
	T3 = 25.5 °C	T2 = 116.2 °C
18:40	T_{in} = 24.3 °C	T_{out} = 29.6 °C
	T3 = 24.8 °C	T2 = 116.8 °C
18:53	T_{in} = 24.3 °C	T_{out} = 29.0 °C
	T3 = 24.8 °C	T2 = 116.4 °C

Overall current 532 mA. Voltage 230 V.
Current through resistance was zero, voltage also zero.

18:57 Measured outflow of primary circuit in heat exchanger, supposedly condensed steam, to be 328 g in 360 seconds, giving a flow of 0.91 g/s. Temperature 23.8 °C.

19:03	T_{in} = 24.5 °C	T_{out} = 29.8 °C
	T3 = 24.9 °C	T2 = 116.6 °C

Overall current 535 mA. Voltage 230 V.
Current through resistance was zero, voltage also zero.

19:08 Hydrogen pressure was eliminated. Flow from peristaltic pump increased. All electric power switched off.

19:22	T_{in} = 24.2 °C	T_{out} = 32.4 °C
	T3 = 25.8 °C	T2 = 114.5 °C

Measured outflow of primary circuit in heat exchanger, supposedly condensed steam, to be 345 g in 180 seconds, giving a flow of 1.92 g/s. Temperature 23.2 °C.

19:25	T_{in} = 24.3 °C T3 = 26.7 °C	T_{out} = 32.4 °C T2 = 113.3 °C
19:40	T_{in} = 24.0 °C T3 = 27.4 °C	T_{out} = 27.4 °C T2 = 108.1 °C
19:52	T_{in} = 24.3 °C T3 = 27.5 °C	T_{out} = 26.9 °C T2 = 104.6 °C
19:58	T_{in} = 24.4 °C T3 = 27.5 °C	T_{out} = 26.5 °C T2 = 103.1 °C

Notes on temperature measurements.

The temperatures measured at the secondary circuit of the heat exchanger showed some unexpected variations. Even though the thermocouples were attached at well chosen positions this gave an idea of low accuracy.

It should also be noted that after half an hour of water flow, before starting any heating, the temperature at the inlet and the outlet of the heat exchanger still showed a difference of 0.5 degrees centigrade, the outlet water being cooler than the inlet water (at that time, the primary circuit was still empty as the E-cat was still filling up).

Energy calculation

The E-cat was considered to be completely operating only after reaching self sustained mode (from 15:53). The heat power transferred to the secondary circuit is calculated through the temperature difference, ΔT, multiplied by the water flow.

Given the doubt of the accuracy of the measured temperatures, conservatively ΔT can be considered half a degree less than the lowest value revealed, 4.7 degrees (at 18:53).

The average flow was 178 g/s.

Heat capacity of water is 4.18 J/(g x K)

With ΔT= 4.2 this gives:

Power required for heating water, P_{heat} = 178 x 4.18 x 4.2 = 3125 W

Input electric power in self sustained mode was 0.5A x 230 V = 115 W, which could be subtracted giving a net power of about 3 kW.

Total energy produced:

In about 3:30 hours of self sustained mode (from 15:53 until 19:25), a total energy of P_{heat} x 3.5 = 10.5 kWh were then produced, or 38 MJ.

Another way to calculate the power produced is to consider all the water at the output from the primary circuit as condensed steam. At 18:57 output flow was measured to be 0.91 g/s.

If this corresponds to the same flow being vaporized in the E-cat, and given that enthalpy of vaporization is 2260 J/g, this would require a heating power of 2260 x 0.91 ≈ 2 kW

Conclusion:

The accuracy of the measurements during this test must be considered fairly low.

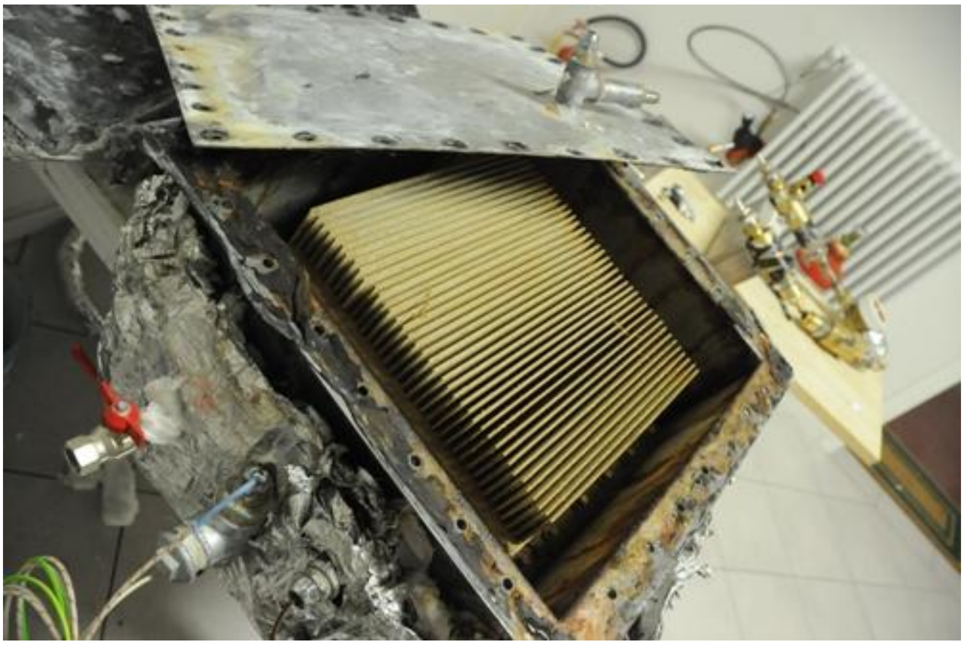
Still, the measurements should lead to the conclusion that this model of the E-cat produced heat at a power of at least 2 to 3 kilowatts in self sustained mode, in this case supposedly with only one of three reactors inside the casing in operation.

As a heat exchanger was used in this set up, steam quality had no importance for the calculation.

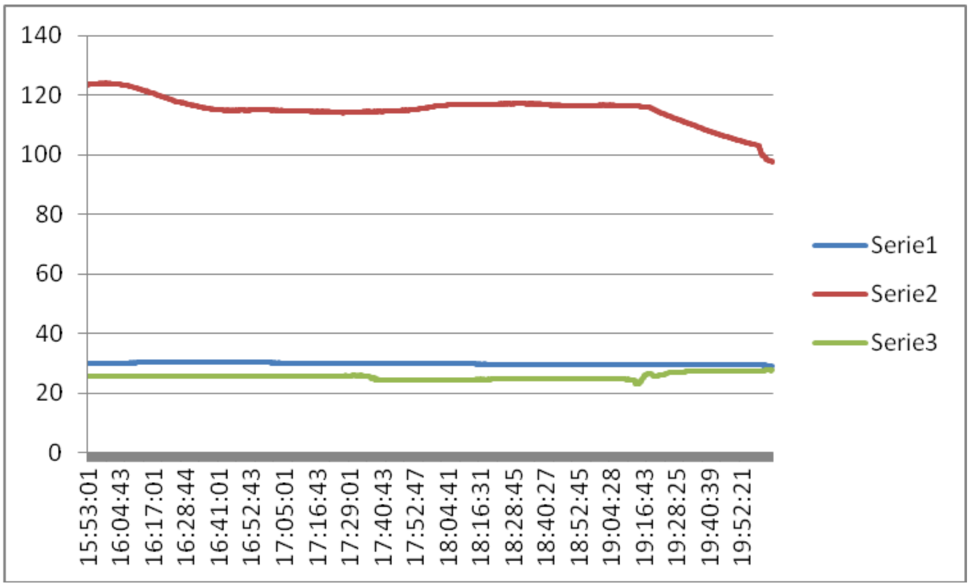
The self sustained mode that went on for over three hours, also seemed extremely stable and showed no measurable sign of weakening.

It can also be noted that after three and a half hours of self sustained operation water could still be felt boiling inside, putting a hand on top of the insulated casing. The surface temperature of the insulation was then between 60 and 85 degrees centigrade, meaning that a significant heat loss must have decreased the power output through the steam and the heat exchanger.

Report by Mats Lewan – mats.lewan@nyteknik.se



The E-cat casing opened, showing the heat exchanger supposedly containing a shielded flat reactor body consisting of three reactor chambers.



Temperature inside the E-cat during self sustained mode (from 15:53 until about 19:15). Serie 1 is room temperature, Serie 2 is output temperature, Serie 3 is inlet temperature.

Instruments

* Peristaltic pump NSF
Model # CEP183-362N3
Serial # 060550065
Max output 12.0 liters/h
Max press 1.50 bar

* Temperature logger Testo
177-T3
0554 1765 Usb Interface

* Scale
Model: TKW 15 S
S/N: 2917029003
Max 15000 g
d= 0.1 g
Certified according to ISO 9001:2000

* Digital bathroom scale used for weighing the E-cat. It was calibrated by two persons knowing their weight.

* Clamp Amperemeter Digimaster DM201
1090647637

* Clamp Amperemeter Mastech MS2102 AC/DC
10030032671

* Multimeter Hung Chang HC-5010C

* 4 channels thermometer Lutron TM-947SD, temperature probe TP-01.

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