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The proposal for the TILECAL submodule surface protection with DISKOR V2076-7

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Abstract

The results of extensive tests - according to DIN standards for the 12 iron surface protection agents against corrosion are summarised. We describe full size tests of horizontal and vertical dipping for two TILECAL submodules performed at CERN in 1997-8. The possibilities to improve optical properties of the light collection system for submodules are suggested.

Contents

1 Introduction

The Tile Calorimeter will be constructed from the 3x64 independent iron modules over a period of 5 years in 9 laboratories with different climates. Each barrel module is built from 19 individual submodules constructed in 6 different laboratories and then transported to module assembly locations, and finally to CERN in the year 2002.

We anticipate that steel surface protection against corrosion will be important not only during transport and assembly period but also during installation and exploitation of the calorimeter.

For the protection of submodules used for construction of Barrel & Extended Barrel MODULE0's we have tested "environmental friendly" water-based coating CORTEC (TM) diluted in the ratio 1:5. The CORTEC solution was applied by dipping of completed submodule in a special $\approx$ 150 l tank. The SUBMODULE manipulation tool, which allows to rotate submodule along the main horizontal symmetry axis was constructed for this purpose [1].

The experience during MODULE0 construction showed, that we could not avoid completely surface corrosion of protected submodules. We have also found out, that contact of protected surface with wooden palettes is speeding up corrosion significantly. Therefore we have tested other products, keeping in mind the possibility to improve optical properties of TILECAL submodules - by using of colour paints (including water-based styrene acrylate).

2 Comparison of the tested protection agents against corrosion

Within the MODULE0 program we have completed series of long term tests to compare protection effectiveness for 12 different agents. We have exposed the protected steel samples $5 \times 15 \div 15 \times 20$ cm^2 according to DIN standards to the water vapour with 100 % humidity at $40 \div 55$ °C. During the tests we have monitored the time dependence of increase of the corroded area. The results are summarised in Table 1.

DISKOR V2076-7, aqueous dispersion of copolymer styrene acrylate, resulted as the best candidate for TILECAL surface protection and was chosen for the full-size tests with 2 submodules at CERN. Both types of DISKOR - V2077 (more viscous) and V2076 are suitable for final protection. Just amount of water used for dilution to the optimal viscosity 20 sec is slightly different.

3 DISKOR properties and thickness of paint vs emerging speed

For the Essential Technical Data, Steel Pre-treatment, Application Data, Examples of Coating Process, and Conditions of Application – see the leaflets of the producer "BARVY TEBAS" PRAHA.

We should stress however, that for our purpose the dipping of submodule is the only possible method. For the emerging speed we recommend $3 \div 6$ cm/min. To speed-up drying process for the surface inside the submodule gaps, we have to use fans, which supply fresh air to the inner surfaces. This will allow us to paint submodules even at the relative humidity higher than 75 %.

The most important parameter is the thickness of paint layer after drying. We believe, that just one dipping will be enough to achieve optimal thickness $0.02 \div 0.05$ mm. In a series of tests we have found out, that the main factors which regulate the paint thickness are:

- paint viscosity = $18 \div 25$ sec
- emerging speed = $3 \div 10$ cm/min
- surface roughness = N6 / N7 ISO
- angle of painted plane to vertical > 20 degree

The results of our tests are illustrated on Fig. 1.

In all parameters we have large acceptable intervals, which guarantee that we can obtain stable and satisfactory results. If we choose black colour to minimize cross-talk between different channels, just one dipping of submodule into black DISKOR will be sufficient. To obtain surface of white colour (i.e. the dispersive reflector as good as TYVEK) two dippings in different paints will be necessary.

4 Vertical vs horizontal dipping of submodules

The main advantage of using CORTEC (TM) with respect to more viscous colour paint was, that **horizontal** dipping of submodules gave us quite homogeneous layer in one operation within ≈ 20 min. When we have used the same procedure with the colour paint we were surprised, that bottom surface of submodules (with the grooves for fibres) had very thick layer of paint which had to be removed by a brush. During horizontal dipping the angle between normal to plane and vertical direction was < 10 degree. Then we have checked experimentally, that without change of "dipping geometry" we can't overcome this serious problem. Fortunately, we have realized soon, that changing of the dipping geometry to almost **vertical** one, doesn't represent a complication of dipping procedure. The construction of tank for vertical dipping was simple and quick. Vertical dipping gave us excellent covering of the whole submodule (including the surfaces with grooves for fibres) without any additional touch. That's why we believe, that vertical dipping is the only candidate for the submodule protection with colour paint.

5 Painting of the two submodules at CERN

In all tests i.e. for vertical (horizontal) dipping we proceeded as follows :

Cleaning of TILECAL submodules

- old paint removed with solvent
- rust removed by mechanical grinding with emery (sand paper)
- glue from the holes for calibration tubes removed by drill (borer of diameter 9 mm 300 mm long) and then cleaned with compressed air
- all 22 holes filled with the stopper rods of diameter 9 mm $\approx$ 295 mm long

Adjusting of the paint viscosity by diluting to $T_p \approx 18 \div 25$ sec

- we assume that viscosity is measured with the Ford cup of diameter 4 mm

  At normal conditions the viscosity of Glycerin $T_g \approx 24$ sec can be used as the reference value for calibration purpose
- mix-up carefully the paint, starting from the bottom of the can.

  If DISKOR V2076 is used ($T_6 > 30$ sec) we expect , that adding ≈ 0.4 l of demineralized water to 20 kg of paint will be sufficient

  If DISKOR V2077 is used ($T_7 > 45$ sec) we expect , that adding ≈ 1 l of water to 20 kg of paint will be sufficient to achieve $T_p \approx 25$ sec
- Preparation of vessel, equipped with the rotary pump - pumping speed $V_{out} \approx 3 \div 30$ l/min
- (for horizontal dipping we have tested also special chain pulley block used for very slow lifting of the submodule from the vessel with paint. $V_{up} \approx 3$ cm/min)
- for vertical dipping submodule was equipped with backing strips in the 8 corners (for keeping distance from the vessel) inserted into the empty vessel

- Filling of the vessel with diluted DISKOR V2076 $\approx$ 90 l (or DISKOR V2077 $\approx$ 50 l which we have used for the painting of only one half of submodule in horizontal geometry).

  We can't recommend to use the pump for filling of the vessel with paint - because of danger to produce a foam on the surface of DISKOR.

- Eliminating of bubbles from the surface of paint – it is also possible to move bubbles to the edge of the tank

- Pumping of paint from the vessel - the emerging speed is adjustable by changing the RPM of the driving motor.

- Lifting of the submodule from the empty vessel - the crane was always used for this purpose

- (Only for the horizontal dipping ! Removal of the thick layer of paint from the bottom surface with grooves ! - best way was to use the brush)

- Rotate the (half) painted submodule by 90^o - moving the master plates with the help of the manipulation device to horizontal position

- Drying the inner surfaces with a fan box .

6 Dimensions of tank, technical characteristics of pump, comments

So far we have constructed two wooden water-tight tanks, with the inner dimensions as illustrated on the Fig. 2. The dimensions of the tank for vertical dipping are derived from the submodule envelope plus $\approx$ 3 cm. In Prague laboratory we have successfully tested wooden tank with the removable side plate of the dimensions $425 \times 1905 \times 20$ mm^3. Steel L profiles $30 \times (20 \div 30) \times 3.5$ mm^3 were used to strengthen the constructed vessel and facilitate the manipulations. The 1/2" tap mounted on the tank close to the bottom was used just for the emptying (not for filling) of the tank. We plan (in Prague & Barcelona), that we will empty the tank (during the painting) at regulated speed with the help of rotary pump, which will fill the reservoir, placed above the upper edge of tank. We have to stress here once more, that it is desirable to fill tank with the submodule without using the pump.

Technical characteristics of the rotary pump "ROWER" type DRILL 20 :

RPM [revolution per minute]	1500 - 3000
Power input [W]	200 - 350
Noisiness [db(A)]	71 - 75

Delivery	[l/min]		12 - 35
Draught	[m]		9 - 30
Suction	[m]	vertically	2 - 6
		horizontally	10 - 40
Connectors to hose			1/2" or 3/4"

7 Conclusion

- DISKOR fulfils all our requirements for the TILECAL surface protection agent.
- Full size tests with submodules at CERN gave only acceptable results for horizontal dipping and very good results for almost vertical dipping of submodules.
- We are looking forward to production of the first TILECAL submodules painted in black with DISKOR.

References

[1] ATLAS Collaboration, ATLAS Tile Calorimeter Technical Design Report, ATLAS TDR 3, CERN/LHCC/96-42, 1996, page 72, CERN, Geneva, Switzerland.

Table 1: Comparison of 12 surface protection agents

Paint	Producer	Colours	Price [CHF] per		Viscosity	Dilutant	Emerging speed	Thickness	Corroded area [%]
			litre	submodule	t_v [sec]	(solvent)	v_{out} [mm/sec]	[μm]	after 300 hours
DISKOR	CZ TEBAS	grey red-brown black	4	8	25	water	$0.3 \div 1.0$	$35 \div 50$	0
UNI-PRIMER	CH Maeder	green white	10	2	25	Dilutant 100	1.0	4	7
LUXONOL	CZ COLORLAK	white	4	1	18	S6006	1.0	5	2
LUXOL	CZ BALAKON	clear	4	1	15	S6006	1.0	4	5
HAMMERITE	UK HAMMERITE PRODUCTS	white green	15	30	120	S6005	1.0	50	0
ZEBRAKRYL	SK MATADOR	white	4	8	50	Toluen	1.0	30	80
ZEBRAPEN	SK MATADOR	white	4	8	100	Toluen	1.0	50	8
UMAKOR	CZ	clear	3	0.5	15	–	1.0	1	99
CORTEC	USA	clear	10	0.5	15	water	1.0	1	80
BLOXID	USA WIRPO	clear	28	6	15	–	1.0	4	8
RESISTIN ML	CZ CHEMO	clear	4	3	30	S6001	1.0	20	0
SIDERZINC	USA	grey						20	2

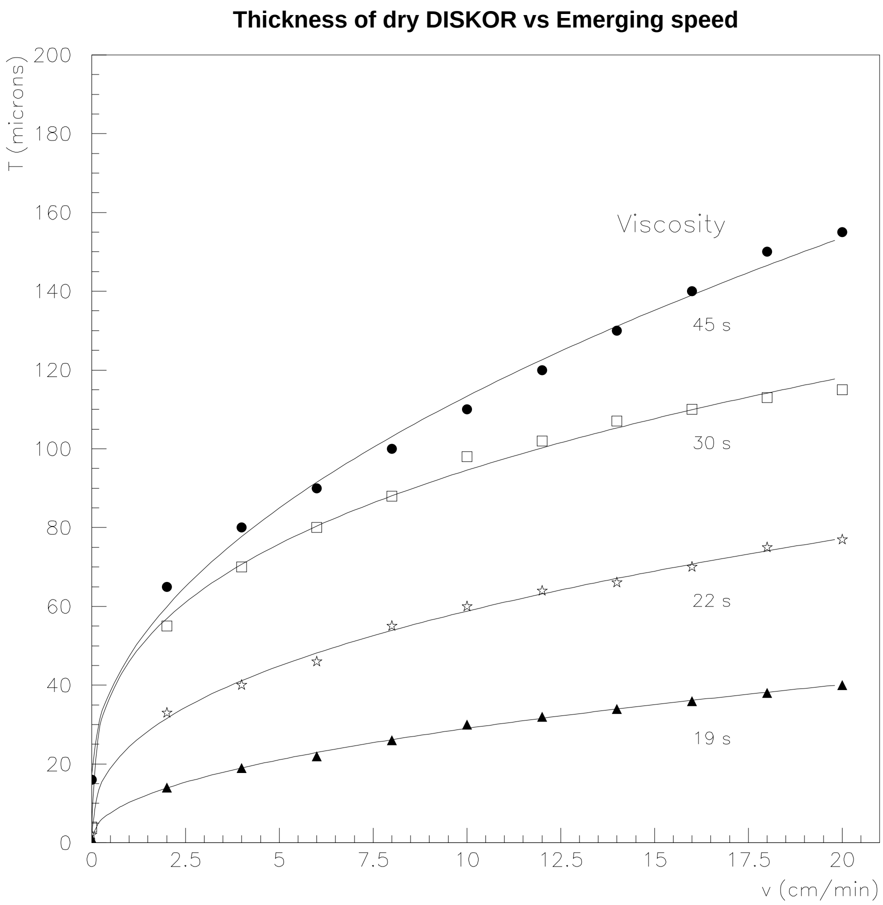

Figure 1: Thickness of paint vs emerging speed.

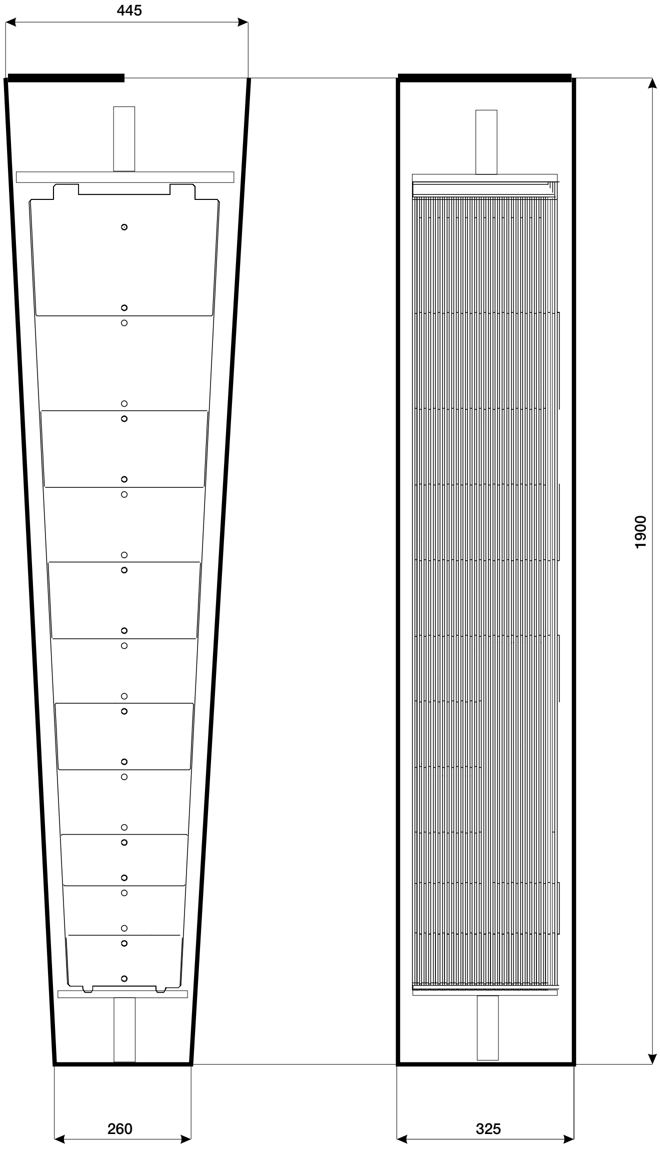

Figure 2: Scheme of the water-tight tank.