BERGEN - 15.04.2009

Ref. No.: GexCon-09-F44124-RA-1
Rev.: 01

REPORT

Testing of Monti MBX Bristle Blaster Tool in Explosive Atmospheres

Client

Monti Werkzeuge GmbH

Author(s)

Matthijs van Wingerden

Document Info

Author(s)

Matthijs van Wingerden

Classification

Confidential (F)

Title

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Extract

As part as an ignition safety assessment in accordance with the ATEX 94/9/EC directive a series of experiments have been performed in order to investigate the potential ignition sources that are produced under normal use and expected malfunctions during use of the Bristle Blaster tool. Experiments were performed in atmospheric and explosive atmospheres in order to characterise operating temperatures and ignition properties of explosive vapours.

Project Info

Client

Monti Werkzeuge GmbH

Clients ref.

Martin Jennes

GexCon Project No.

44124

GexCon Project Name

Experimental testing

Revision

Rev.	Date	Author	Checked by	Approved by	Reason for revision
00	09.02.2009	Matthijs van Wingerden	Geir H. Pedersen	Brian A. Wilkins	Report issued to client for comments.
01	15.04.2009	Matthijs van Wingerden	Geir H. Pedersen	Kees van Wingerden	Report issued to client as final report.

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1 Introduction

Reference is made to communication between Martin Jennes, Monti Werkzeuge GmbH and Geir H. Pedersen, GexCon, regarding the performance of an ATEX conformity and ignition safety assessment, to be performed in cooperation with GexCon, for the evaluation of a new surface treatment tool, MBX Bristle Blaster to allow ATEX approval of the system as category 2 equipment for use in zone 1 for explosive atmospheres according to the ATEX 94/9/EC directive. As part of this process, experimental testing has been performed in order to verify whether or not the tool can cause ignition when operated in explosive gas/vapour atmospheres. This report describes the experimental work performed and the results obtained.

The experimental testing comprised of two phases. During the surface temperature measurement phase, a high-speed infrared camera was used in order to find the worst case operating conditions during normal operation of the tool. During this test the tool was used on various types of materials. Different MBX bristle blaster belts were used and different loads applied to the tool.

The second phase consisted of testing the worst case scenario found in phase 1 in explosive atmospheres. The gas reactivity target for ATEX evaluation is gas class IIA. Hexane and petrol vapour are considered among the easiest ignitable gases within this class and both were therefore used during this work.

Tests were performed at GexCon's test laboratory in Bergen during December 2008.

2 Experimental set-up

2.1 The MBX Bristle Blaster Tool

The MBX bristle blaster is a pneumatic tool for metal surface maintenance, see Figure 2.1. The tool consists of wire bristle tips mounted on a rotating hub of a hand-held tool which operates at approximately 2500 rpm (powered by compressed air). The tips of the individual brush wires hit the surface and immediately retract which results in corrosion removal and generates a texture on the surface. This process can result in both locally hot surfaces and mechanical spark generation. The experiments performed aimed at showing whether this can result in an ignition of a class IIA explosive atmosphere.

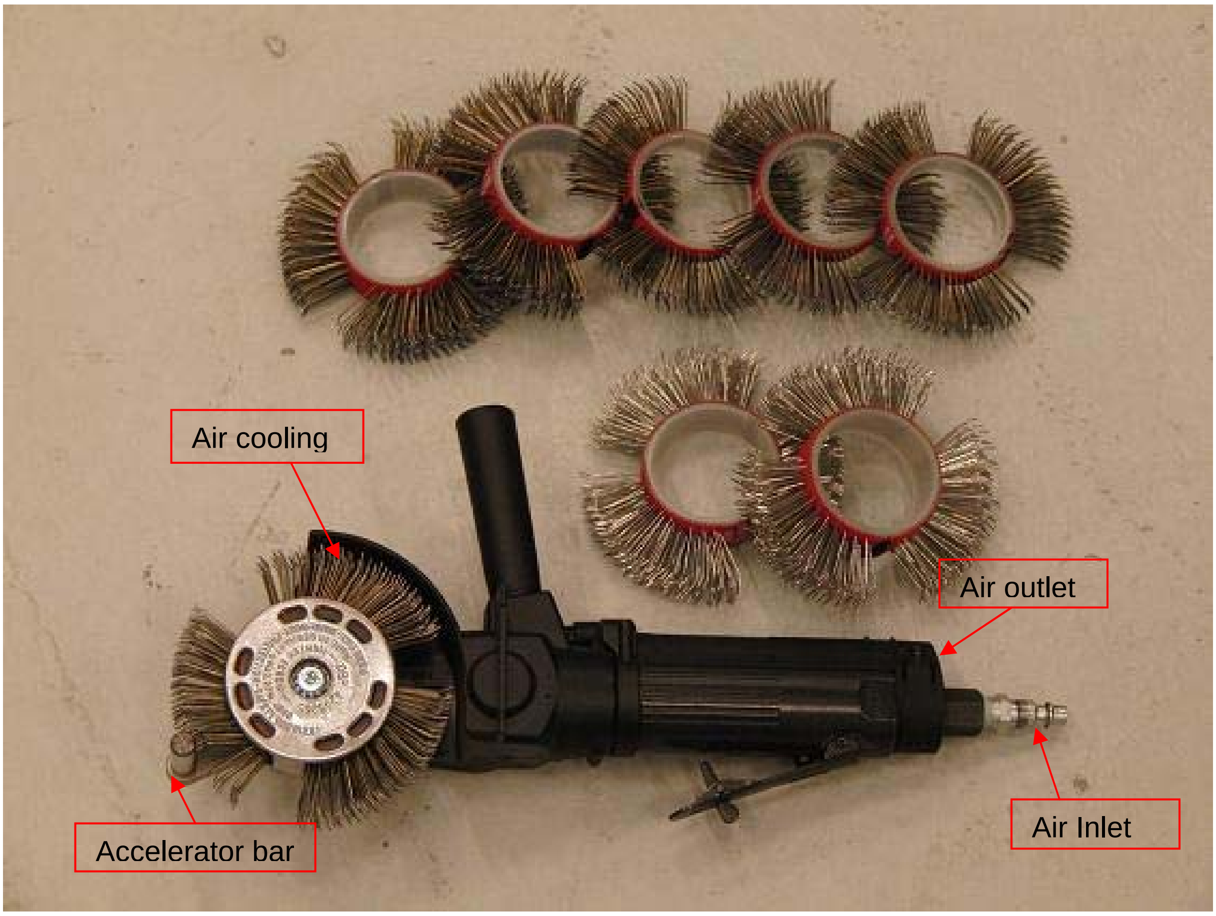


Figure 2.1 MBX Bristle Blaster tool

The tool was provided with three different types of brushes (MBX Bristle Blaster belts):

- MBX Bristle Blaster belt 23 mm (golden coloured)
- MBX Bristle Blaster belt 23 mm (golden coloured) without hardened tips
- MBX Stainless Steel Bristle Blaster belt 23 mm (white steel coloured)
- MBX Bristle Blaster belt 11 mm (golden coloured)
- MBX Bristle Blaster belt 11 mm (golden coloured) without hardened tips

The MBX Bristle Blaster belts without hardened tips were received at a later point in time and thus were only tested in an explosive atmosphere (i.e. no temperature measurements were performed).

A few modifications were made to the tool in order to allow it to be remotely operated in an explosive atmosphere, see Figure 2.2. The air cooling system was blocked and air from the air outlet was redirected through a tube to the outside of the test volume to avoid fresh air from diluting the gas mixture. Loss of air cooling is identified as an expected malfunction during normal operation. The handle was also fixed in the “ON” position with tape. This allowed the tool to start when the pressured air is switched on, allowing the tool to be remotely operated.

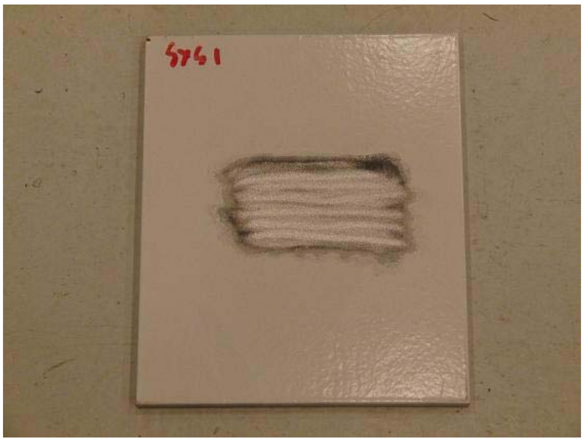
Figure 2.2 Modifications made to the MBX Bristle Blaster in order to test the tool in an explosive atmosphere.

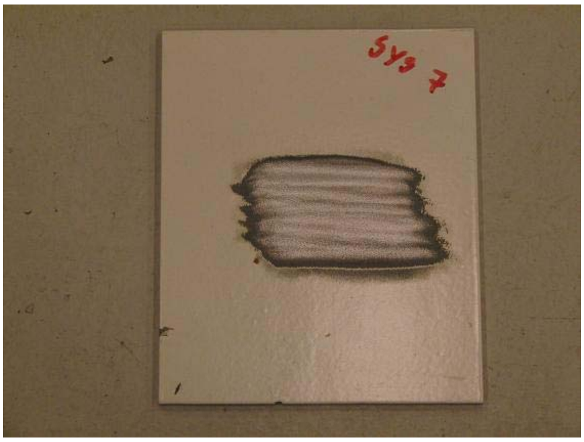
2.2 Test Materials

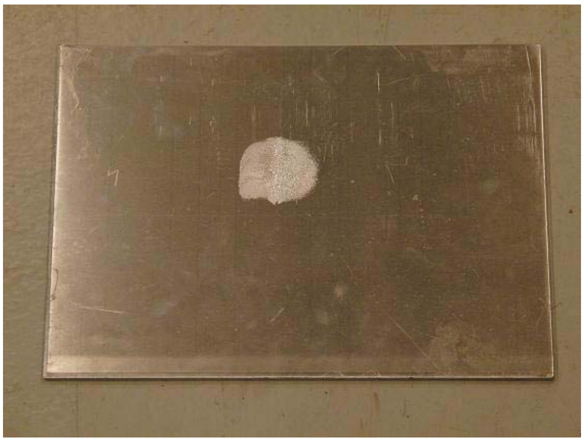
In order to find the worst case scenario for bristle blasting, a total of 6 different types of materials were used for testing. The different materials are shown in Figure 2.3.


a) “CART” treated steel (chartec covered)


b) Rusty steel


c) “SYS 1” treated steel


d) “SYS 7” treated steel


e) Aluminium type 1


f) Aluminium type 2

Figure 2.3 Photographs showing the different types of materials used during the experiments.

2.3 Infra red camera

During the first phase of testing, a high speed infra red camera of the type Cedip – Jade MWIR was used to measure the temperature generated by the bristle blasting process.

According to the instrument calibration, the camera has an accuracy of 0.1 °C, depending on the accuracy of the emissivity settings and parameters used for the camera during use.

2.4 Experimental set-up for tests performed in explosive atmospheres

The test volume used in the ignition experiments performed in explosive mixtures was a 1.5m^3 steel cabinet, open on 3 sides. As part of this cabinet an external gas recirculation system was mounted, sucking gas from the far right bottom corner of the cabinet and blowing the gas back into the cabinet at the front top left corner. The recirculation system was used to "mix" the explosive atmosphere and allowed the generation of a homogeneous atmosphere in the cabinet.

Both hexane and petrol were used during this work and were chosen as test vapours due to their ignition sensitivity to hot surfaces (minimum ignition temperature 225°C and 380°C respectively). This was done in order to cover gas class IIA adequately and beyond that possible by using propane as a test gas alone (minimum ignition temperature 450°C). The minimum ignition energy of these three gases/vapours is however similar (0.25-0.26 mJ).

Liquid hexane or petrol was added at the top of the cabinet and was fed via a pipe directed into a heated cast-iron pan placed inside the cabinet. In the cast-iron pan the liquid vaporised. The concentration of the gas mixture in the cabinet was determined by the amount of liquid injected. The concentration was monitored by sucking the vapour-air mixture from a few positions inside the cabinet to a hydrocarbon sensor, type Biosysyems PhD Plus Atmosphere monitor. This gave an indication of homogeneity of the gas mixture inside the cabinet. The sensor did not give quantitative values of the fuel concentration, but a good indication of the homogeneity of the mixture. Different amounts of fuel were used, in other words tests were performed over a wide range of fuel concentrations. To confirm that the gas mixtures were explosive during the tests when the MBX tool was operated, they were ignited after each test using an electric spark. First of all this proved that the gas mixture was explosible after grinding was stopped, and the flame colour and speed gave an indication of the concentration of the gas mixture, in other words whether the concentration was below, above or near stoichiometric (ideal) conditions.

The MBX bristle blaster tool was modified as described in section 2.1 and mounted on a robot arm in order to remotely control and press the tool onto the test material, see Figure 2.4. The robot arm was remotely operated using pressurized air.

The load applied to the tool could be varied by changing the pressure applied to the pneumatic cylinder. Various grinding forces were applied during testing. The highest load which did not produce a considerable reduction in the rotation speed of the tool was chosen for the tests. The load was "calibrated" by letting the tool push onto a set of electrical scales and was measured to be equal to 1.8 kg, see Figure 2.5.

The load applied was considered to be a little greater than a person or operator would apply during normal operation. A higher degree of loading would significantly slow down the tool and perhaps make the tests less representative and less conservative. The tests continued until steady state conditions were observed (typically 0.5 – 1 minutes).

Figure 2.4 MBX Bristle Blaster mounted inside the test volume prior to testing.

Figure 2.5 Measurement of the load applied to the tool when using the robot arm.

3 Results

3.1 Phase 1 – Infra red camera results

A number of tests were performed using the infra red camera to identify the worst case operational conditions and combinations of the different materials and brush types. All these tests were performed with manual operation of the tool. The tool was hand-held and no modifications were made to the tool, i.e. the air cooling was intact.

An example from an infra red camera recording is shown in Figure 3.1. From the picture it would seem that the bristle support belt becomes warm. This is however not correct. The red colour on the belt seemed, in addition to visible red light, to also reflect infra red radiation from the environment. The temperature of the parts was checked immediately after the completion of the tests, and it was confirmed that these parts were cold. It was attempted to eliminate the reflections by painting the surface black, but the paint peeled off. This "emissivity error" was eliminated by measuring within areas which excluded the bristle belt itself.

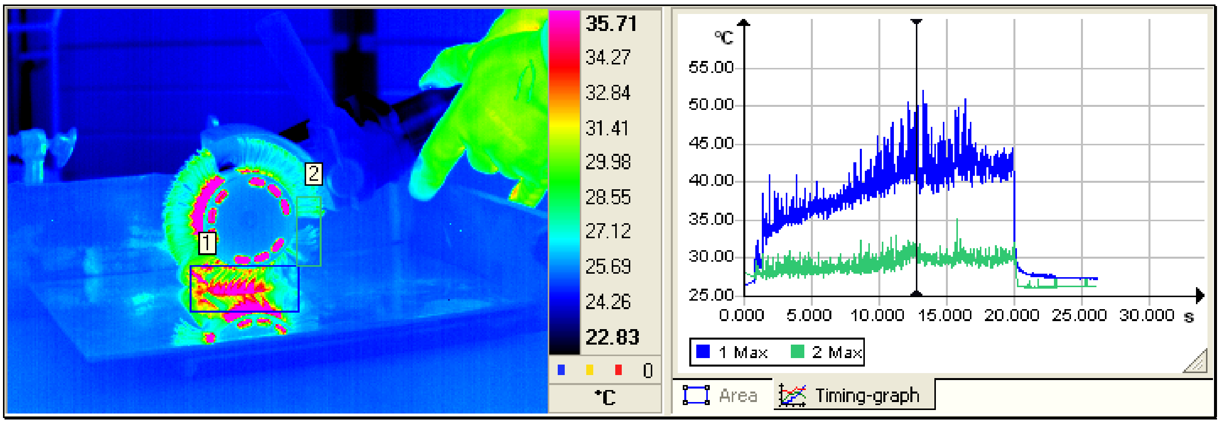


Figure 3.1 ***Typical example from an infra red camera recording. The graph shows the maximum temperature measured within the rectangular areas marked on the picture over time. 1) is the temperature of the material surface. 2) is the temperature of the brush after it has left the surface.***

An initial test performed using the infra red camera showed that the amount of force applied to the tool had little to say for the maximum temperature measured.

The results from the tests are given in Table 3.1. The highest temperature that was measured was 105°C. This was obtained when the tool was operated on the chartec (CART) treated steel surface. These results indicate that the tool can be classified according to Temperature Class T4. This means that the Bristle Blaster tool can in principle be used with gases and fluids with an ignition temperature higher than 135°C within the limits and safety margins according to Ex-zone (according the hazardous area classification etc).

Table 3.1 Maximum temperatures measured with the infra-red camera using different materials and brush combinations

Test no.	**Material type**	**Brush type**	**Maximum temperature [°C]**	
			Material surface	**Brush/Bristles**
1	Rusty steel	23 mm/White	80	60
2	Rusty steel	23 mm/Golden	60	60
3	Rusty steel	11 mm/Golden	70	40
4	SYS 1	23 mm/White	80	60
5	SYS 7	23 mm/White	95	50
6	CART	23 mm/White	105	50
7	Aluminium type 1	23 mm/White	40	30
8	Aluminium type 2	23 mm/White	90	50

3.2 Phase 2 – Ignition testing in gas mixtures

Based on the results of phase 1 with 105°C as the highest temperature obtained, hot surfaces are not likely to cause an ignition of a hexane-air mixture, having an ignition temperature of around 265°C. However, visible sparks were observed when operating the tool on the rusty steel material. These are potential ignition sources. No sparks were observed on any other of the materials tested. Rusty steel was therefore considered as being the material that most likely would ignite an explosive atmosphere out of all materials tested. Hence, rusty steel was used for all tests performed in explosive atmospheres mixtures.

The tests were performed as described in section 2.4. During each test the tool was operated against the material for about 1 minute and repeated 3 times. Test conditions and results are given in Table 3.2 and Table 3.3. No ignition occurred during any of the tests.

Table 3.2 Test conditions and results for all tests performed in explosive petrol-air mixtures

Test no.	Petrol added [ml]	Approx. concentration [% stoichiometric]	Ignition
1	300	150	No
2	300	150	No
3	110	50	No
4	360	180	No
5	400	200	No
6	420	210	No
7	210	100	No

Table 3.3 Test conditions and results for all tests performed in explosive hexane-air mixtures

Test no.	Hexane added [ml]	Approx. concentration [% stoichiometric]	Ignition
1	190	100	No
2	320	175	No

4 Conclusion

Monti Werkzeuge GmbH has developed a new surface treatment tool, MBX Bristle Blaster. As part of an ATEX approval of the system as “Category 2 Equipment” for use in zone 1 explosive atmospheres according to the ATEX 94/9/EC directive, experimental testing has been performed in order to verify whether or not the tool can cause ignition when operated in explosive atmospheres of petrol-air and hexane-air mixtures.

A number of tests have been performed using an infra red camera to measure the highest temperature obtained during normal operation of the tool on various materials and with different types of bristle tips. The highest temperature obtained was when the tool was used on the chartec (CART) material. The maximum temperature obtained was 105°C.

The tests performed in explosive petrol-air and hexane-air mixtures showed that the Bristle Blaster does not produce strong enough ignition sources to ignite the explosive atmospheres. Therefore, it is considered that it is very unlikely that the MBX Bristle Blaster tool represents an ignition hazard when used in connection with “Class IIA” gases and vapours, provided the tool is not used significantly differently or more brutally than in the tests performed here.

The reported tests were performed under conservative, but realistic conditions. Due to the nature of the bristle tips, a higher load on the tool will result in reduction of the rotational speed or stop the tool rotating completely.