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The dangerous Optical Power in potentially Explosive Atmospfere measuring

Optical fibers in Ex

[Martin Kyselák, Martin Mafka]

This paper deals with the problem of optical fibre communication in potentially explosive atmospfere / hazardous area. Optical fibers are traditionally safe and useful in all environment, but it is shown, that a dangerous mix of explosive gas can be a big problem for optical fibres.

OPTICAL FIBRE, EXPLOSIVE ATMOSPHERE, HAZARDOUS AREA, OPTICAL POWER.

I. Introduction *(Heading 1)*

Optical fibers are widely used nowadays because of its very low attenuation and very high transfer rates. Fiber optic cables are not current carrying, therefore could be deployed in environments containing explosive gases without causing ignition. There is a danger of explosive atmosphere ignition when using optical radiation (corrupted optical fiber is the source of light radiation which should cause basically an explosion). Hence, it is crucial to protect systems using optical fibers.

Types of protection are: inherently safe optical radiation, type of protection “op is”, protected optical radiation, type of protection “op pr” and optical system with interlock, type of protection “op sh”.

TABLE I. SAFE OPTICAL OUTPUT AND INTENSITY FOR DANGEROUS PLACES DEPENDED ON (CLASS I AND IIC)

Explosion group	***I***	***IIC***	
Temperature class		T4	T6
Surface temperature (°C)	≤ 150	≤ 135	≤ 85
Power (mW)	150	35	15
Irradiance (mW/mm^2) (surface area not exceeding 400 mm^2)	20*	5	5
* For irradiated areas greeter than 30 mm^2, where combustible materials may intercept the beam, the 5 mW/mm^2 irradiation limit applies.			

TABLE II. SAFE OPTICAL OUTPUT AND INTENSITY FOR DANGEROUS PLACES DEPENDED ON (CLASS IIA NAD IIB)

Explosion group	***I***	***IIC***	
Temperature class	T3	T4	T4
Surface temperature (°C)	⩽ 200	⩽ 135	⩽ 135
Power (mW)	150	35	35
Irradiance (mW/mm^2) (surface area not exceeding 400 mm^2)	20*	5	5
* For irradiated areas greeter than 30 mm^2, where combustible materials may intercept the beam, the 5 mW/mm^2 irradiation limit applies.			

Tables I and II are taken over CSN EN 60079-28 standard and declare the maximum allowed output and light intensity for different types of devices. These values should not be exceeded for different kinds of devices in particular dangerous environment.

II. Steps during measuring

The workplace was connected according the Figure 1. To avoid overheating the LD, the temperature set on thermal stabilizer was 20st. This temperature is not just set, but checked as well. The current limit value was set on the generator to avoid exceeding max value allowed on LD. Light detector was placed as near as possible to the source of optical radiation (distance between detector and source of optical radiation l = 1 cm).

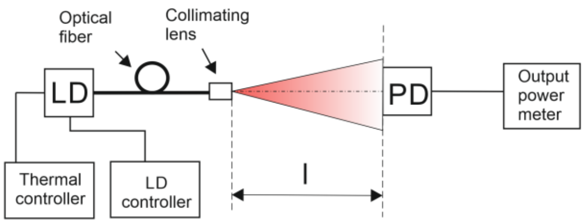

Figure 1. Block diagram for measuring light power output.

During the measurement the values on a generator was rising up to the current limit and the optical output power was measured. After reaching maximum value of the current the actual current was set to the minimum value, meanwhile the light detector’s position was changed in range (from 1 cm to 10 cm). After changing the distance between the light detector and the light source the measurement started again with rising up the actual current and noting optical output power values.

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Measurement was executed for two different laser diodes:

• For λ = 635 nm – LPS-PM635-FC

• For λ = 1550 nm – LPS-PM1550-FC

III. Assessment and measurement of 635 nm source of light radiation

The results expected after the measurement were according to fact that with rising distance between the light detector and the source of light radiation the optical power output would descend.

However, the real values, which are in Figure 2, do not follow the expectation declared before the experiment.

Figure 2. Picture of coplete workplace.

Measured optical power output is between 1 cm and 6 cm rising instead of descending. From the distance between 6 cm to 10 cm the measured optical power output is descending. The optical power output measured in 10 cm distance is higher than the optical power output measured in distance of 1 cm. The reason explaining deflections is because the source of optical radiation was not directed into the active area of the light detector.

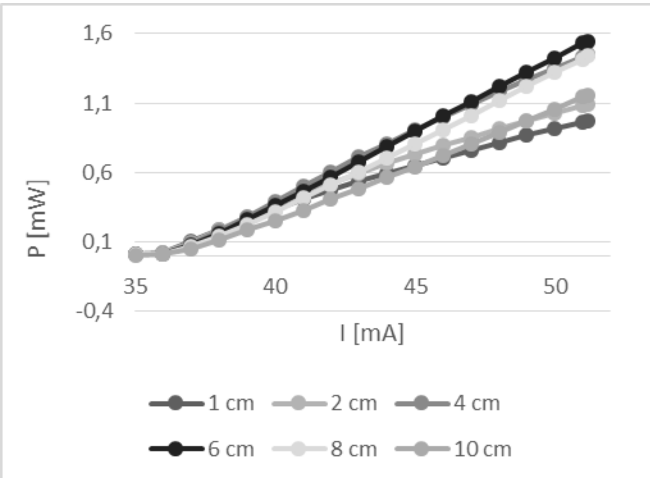

Figure 3. Output power LD (LPS-PM635-FC) dependence on actual current. Temperature is equal to 20st and different distances were taken into account.

It is vital to consider that during the operation of the corrupted fiber system all the optical power output could radiate into a single point in space. In this case, the light intensity is equal to the optical output power.

In this scenario was used LPS-PM635-FC source of light radiation, which max optical output power is 3,5 mW.

The max light output power is no more than 5 mW and the light intensity limit, which is 5 mW/mm^2 is not exceeded as well. Therefore, this type of light radiation source could be used in all kinds of dangerous environments without necessary additional protection.

IV. Assessment and measurement of 1550 nm source of light radiation

The expected results during this measurement should be again similar to the fact that with rising distance between the light detector and the source of light radiation the optical power output would descend.

Current [mA]	Power [mW]	
Distance between detector and source of optical radiation [cm]	1	5
20	5,3	4,9
30	11,0	10,2
40	16,8	15,4
50	22,1	20,7
60	27,6	25,4
70	32,4	30,0
80	37,1	34,9
90	41,6	40,0
100	46,3	45,1
110	50,8	49,0
120	54,9	53,2

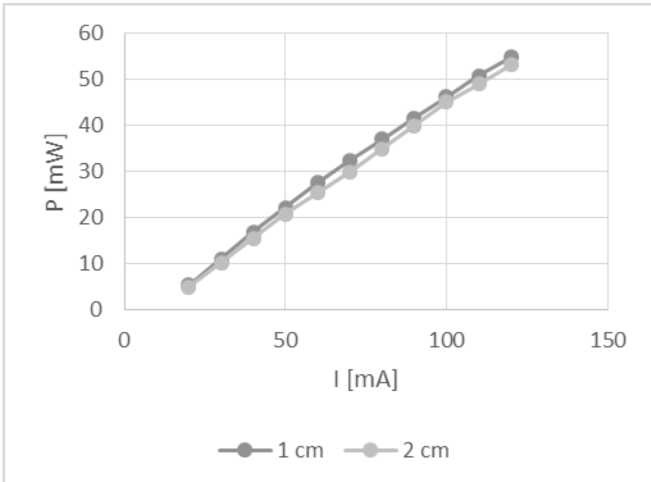

Figure 4. Output power LD (LPS-PM1550-FC) dependence on actual current. Temperature is equal to 20st and different distances were taken into account.

During this measurement the malfunction of the source of light radiation has been discovered. Hence, its light power output is few times more than max allowed value, what is more than 1,8 mW.

V. Conclusion

There could be two types of failures. The first kind may include unexpected reasons, immediate failure of measuring instrument, wrong initial settings etc. Mentioned category could not make such an influence on the measured values. The other type of failures can result in such a differences, when for example, the faulty LD was used (blown LD has different physical characteristics).

There is a danger when using corrupted optical fiber systems in an explosive environments. The measured values indicate that maximum light output power for light source LPS-PM1550-FC is 1,8 mW. In case of failure of the optical fiber systems the maximum light output power exceeded its declared value several times, what should cause an explosion when deployed in explosive environments. Hence, it is very important to protect optical fiber system components with additional protection to avoid exceed safe values of optical radiation.

Placing the LPS-PM1550-FC light source in dangerous environments without additional protection could be pretty safe, thanks to the max light power output is 1,8 mW, and therefore the light intensity 5 mW/mm^2 is not exceeded. However, the measured values does exceed light intensity limit. As a result, using this source of light radiation in dangerous environments requires deploying additional protection.

In case the LPS-PM1550-FC light source is running in dangerous environments without additional protection used, during the failure the optical fiber acts as the source of light radiation and all the light power output is emitted, causing an explosion. To avoid this situation to happen, protect optical fiber placing into tube, groove or use armored cable, at least where the explosive environments are threating.

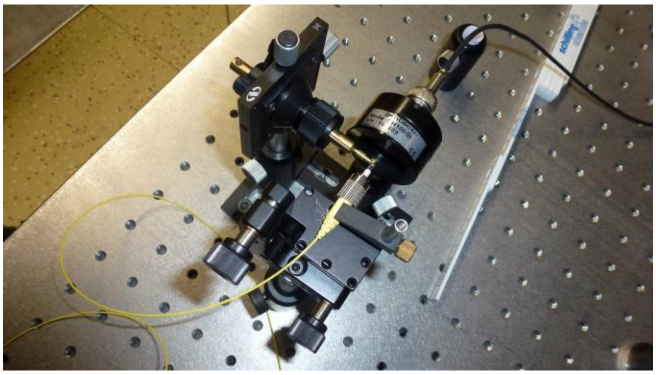

Figure 5. Detail of the termination of the optical fibre, colimating lens and detector.

Another way of protection is the measurement instrument that is constantly measuring the optical power output. During a failure of optical fiber, the instrument detects changed optical power output value and simply turns off light emitting in the fiber. Time needed to stop fiber to transport a light is shorter than time needed to happen an explosion. This type of protection must be very reliable, therefore it is very expensive choice.

Optical power output can be reduced using optical attenuator. This passive element regulates the optical power output with regards to.

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