

Safety devices used in Oxy-Fuel TECHNOLOGY principles and PREVENTION

Manufacturers guidelines must be strictly respected

Basic principle

Oxy-fuel technology means thermal processes as e.g.: flame welding, oxygen cutting, brazing, flame straightening and various preheating methods. Highly intensive and focused flame is needed when operation with oxy-fuel blowpipe. Such flame appears when gaseous fuels are burning with pure oxygen. There are various fuel gases used: Acetylene, Propane, LPG, Natural gas, Hydrogen, Propylene, Ethylene, Oxygen and the fuel gas are supplied from gas cylinders or piping systems through pressure regulators and rubber hoses to the blowpipe. Further they are mixed together in the blowpipe or nozzle in an optimal ratio to create highly reactive mixture. When ignited, this mixture is burning, forming a high-energy flame which is used as a power source for above mentioned technologies. It is one of the first technologies of metal fabrication.

The Oxy-fuel technology is a safe and effective process for quality fabrication of the metals when proper quality equipment is used, operated with correctly set parameters according to equipment producer instruction. Oxygen and fuel gas are going through the blowpipe and they are mixed with optimal ratio to build up a stable flame at the blowpipe nozzle. There are blowpipes with injector mixing system frequently used when fast blowing oxygen is sucking proper amount of the fuel gas due to Venturi-effect. Oxygen pressure is set then higher than fuel gas pressure. When equal pressure mixing system is used, both gases are set at the same pressure level and create the optimal mixture.

Flame related hazards, the backfire and the flashback

The four basic phenomena can occur in case of wrong manipulation with the equipment or process and in case of equipment damage: Gas back flow, Backfire, Sustained backfire, Flashback.

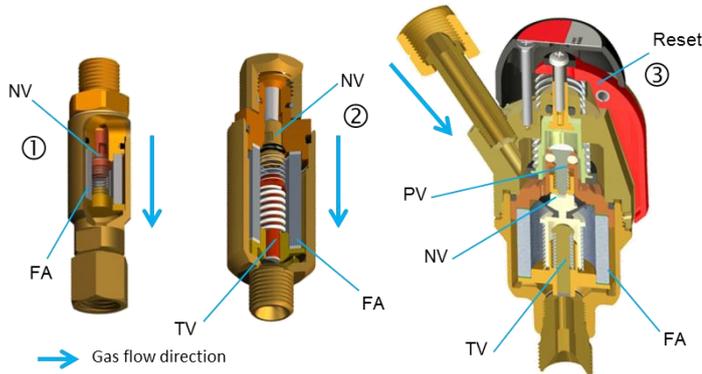
- The **gas back flow** can occur when the outlet of the blowpipe nozzle is blocked. This can happen e.g. when touching the nozzle with the material or in case of pressure drop in one of the gas channels (no gas supply in the hose, gas supply interrupted). Then gas with the higher set pressure is blowing through mixer into the channel with the lower pressure. The hazard is based on the explosive mixture creation in the rubber hoses and its propagation up to the pressure regulator and gas cylinders.
- The flame burning stability is ensured when the speed of burning is equal to the speed of gas delivery. Burning speed of particular fuel gas mixed with oxygen is always constant. Speed of gas flow is influenced by setting of the gas pressure, by adjusting of the flame on the blowpipe valves or when the outlet of the nozzle is blocked by wrong manipulation. When the burning speed is faster than speed of gas flow, the flame can entry inside the nozzle and blowpipe. This situation is called **backfire**. Backfire is followed by intensive/explosive sound. Then the backfire is stopped at the place of gas mixing, where the burning speed is changed. Flame is either extinguished there or blown away of the nozzle to burn stable again.
- But when the nozzle or blowpipe is overheated and its temperature reaches the level higher than ignition temperature of the fuel gas – oxygen mixture, the gas is getting ignited inside the

blowpipe and stays burning inside. This phenomena called **sustained backfire**. The flame is not visible outside the nozzle, just the fume. Internal burning is followed by whistling sound. It occurs when the blowpipe gets overheated either by several backfiring or by wrong operation with the blowpipe. In that case, the gas supply must be closed immediately otherwise the blowpipe can be damaged by melting and in the worst case people can be injured.

- If the gas delivery is not stopped and the flame is not extinguished, a **flashback** appears when the flame travels through the blowpipe and gas hoses up to the gas source. The flashback can cause either hose explosion or when the flame reaches the gas cylinders or the pipeline, it may cause a huge explosion with devastating results.

Preventions

- The most effective way of prevention of the hazards related with oxy-fuel process is to use the best common practice and keeping the general safety rules at the dangerous working place. The special attention should be paid on the fire prevention, fuel gas and oxygen related hazards, stocking and manipulation with the gas cylinders. Gases should be delivered by authorized and quality providers in the packages safe for manipulation and use. Cylinders shall be secured against the fall at the working place. The minimal recommended distance of the open oxy-fuel flame from the cylinders shall follow local rules and conditions. Pressure regulators shall conform to EN ISO 2503, flashback arrestors to EN ISO 5175-1, gas hoses to EN ISO 3821 and blowpipes with nozzles to EN ISO 5172. Instruction for use of all equipment components shall be followed inclusive recommendation of the parameters set up to get safe, stable and efficient flame. Equipment can only be used with the gas type it is designed for. Follow the equipment marking.
- **Two-function FBA** ① integrates non-return valve (NV) with flame arrestor (FA). The flame arrestor is a high porosity and small pore size sintered metal element where the gas is going through. When the flame reaches sintered metal element, it is split into porous structure and extinguished there. Two-function FBA is recommended to be installed at the blowpipe shank or between the hoses.
- **Three-function FBA** ② contains besides above mentioned features also a thermal valve (TV). Thermal valve is activated when the body of FBA is heated up. The heating can be caused either internally by backfire or externally, e.g. by fire at the working place. When activated, thermal valve closes gas supply fully off. The flame is stopped this way and FBA needs to be exchanged by new one before starting operating again. Three-function FBA should be used at the at the cylinder regulator or at the outlet-point of the pipeline.
- **Four-function FBA** ③ contains in addition a pressure activated valve (PV). It is actuated by a pressure wave from down- stream side. This happens for example in case of a flashback. The gas flow is stopped but FBA can be reset again and used repeatedly. The four-function FBA is the most sophisticated safety device today to protect oxy-fuel operation. It is to be installed at the cylinder regulator or at the outlet-point of the pipeline.



Requirement for standard compliant marking of safety devices according to EN ISO 5175-1

Every manufacturer applying an EN ISO 5175-1 marking to a new product, has to do a type test according to this standard before launching the product.

A high level of safety can be documented by an accredited external testing institute (third party such as BAM, U.L. or APRAGAZ).

Production tests

The manufacturer of a safety device should subject each flashback arrestor to a flashback test according to the standard. To complete a 100% production test, the function of the non-return valve, the pressure activated valve (only four-function FBA) and a test for external gas tightness should also be conducted.

Each FBA made in accordance with EN ISO 5175-1 shall be permanently marked by:

- The number of the International Standard EN ISO 5175-1
- The name or trademark of manufacturer and/or distributor
- The model designation or code number relating to the manufacturer's installation instruction
- The direction of the normal gas flow (arrow)
- The name of the gas or its abbreviation
- The maximum operating pressure, p_{max} , expressed in bar
- Indication of the safety functions incorporated in the device

Manufacturer or distributor name	Model designation	↓	HPYM- $P_{max} = 5 \text{ bar} / 72 \text{ psi}$ A - $P_{max} = 1.5 \text{ bar} / 21 \text{ psi}$	EN ISO 5175-1
	FUEL GAS			FA NV PV TV
NEXT INSPECTION			14 15 16 17 18 19	⚙
			1 2 3 4 5 6 7 8 9 10 11 12	

Manufacturer or distributor name	Model designation	↓	O - $P_{max} = 10 \text{ bar} / 145 \text{ psi}$	EN ISO 5175-1
	OXYGEN			FA NV PV TV
NEXT INSPECTION			14 15 16 17 18 19	⚙
			1 2 3 4 5 6 7 8 9 10 11 12	

Highest level of protection

To achieve the highest possible level of protection a four-function FBA is fitted to the outlet of the regulator and that a two-function FBA is fitted to the inlets of the blowpipe. This applies to both the oxygen and the fuel gas supplies. FBA installed at the blowpipe inlet stops the flame at the nearest point before its entering into the gas hoses. The four-function FBA at the gas regulator is the last safety point also when the flame is initiated in the hose by external ignition source. It ensures also the gas supply is stopped in case of the fire at the working place

Annual test of safety devices

To maintain the high level of safety during the life cycle of the device, the safety device (flashback arrestors) should be tested for gas non-return, for gas tightness and for gas flow by a trained and authorised person every year (depending on the country specific regulations). Items don't pass the test have to be replaced. This can be done by means of a special testing unit (picture 1). The country specific regulations or recommendations should apply in term of maintenance and replacement.



Picture 1

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