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Oxygen Lancing – State-of-the-art

Introduction

In the German Standard DIN 8522, this process is defined as follows :
"Oxygen lancing is a cutting process which uses oxygen supplied through a consumable steel pipe to pierce holes in metallic and mineral workpieces.
The lance is lighted and steadily consumed. It involves a number of steel wires packed into the steel tube."
The process is based on the principle that the iron pipe burns at approx. 1200 to 2700 °C dependant on the burning iron-to-oxygen ratio. The proper ratio is decisive, and is obtained with the special tube, where ten to twelve steel wires are e.g. packed into a 3/8" (17.2 x 2 dia.) lance. Available tubes are typically 3 and 6 m long, and 1/2", 3/8", and 1/4" in diameter. A brass clamp and dosing valve hold the steel pipe and provide the required oxygen flow. A fuel gas is not required for the process itself, it may, however, be used in a welding torch to heat the cutting end of the lance to ignition temperature.

The most important factor for process economy is a proper oxygen-to-lance material ratio, and this metal-to-oxygen factor shall not below 0.5. Excessive oxygen would 'coldbast' the burning lance, which never must happen. The optimum factor is obtained by using steel wires in the lance tube. They excel profiled inserts in two ways : They offer a large surface to the oxygen, and they provide sufficient sectional area for oxygen flow in cases where the lance is bent.

Maximum piercing results, at minimum lance consumption, lowest oxygen consumption, and longest burning duration, can be expected at a sectional area ratio for
Tube to wire to oxygen of 1.2 : 1 : 0.7.

Principles of operation

An oxyfuel gas torch is used to bring the cutting end of the lance to white heat, and then the oxygen valve is slowly opened to start O2 flow, and initiate the burning operation of the packed lance. The higher the oxygen pressure the higher the burning intensity. The oxygen valve is opened further, and shall be fully open in about 1 to 2 cm cutting depth. A close oxygen flow control will help reduce heavy sparking at start of cut. The deeper the cut the more sparks are eliminated. A baffle plate shall be used in all applications.

To pierce holes, the lance is continually rotated around 90°, clockwise and counterclockwise, while slight pressure is applied to advance the lance. Once in the hole, the lance is moved in a poking manner, in order to obtain the required combustion

plume at the lance end, and improve slag ejection. This undisturbed slag removal is a determining factor for the process efficiency. Consequently, hole piercing “upwards” would bring best results. This is, however, limited to very few applications, for reasons of occupational safety and the limited feed length of the lance, which necessarily has to be bent. Therefore, horizontal lance cutting is the best suitable solution; the lance is held in a slightly upwards pointing position. Cutting can also be performed with the lance perpendicular to the workpiece. This application, however, requires optimum guidance of the lance for safe slag ejection.

Characteristic features to be considered with different materials :

Concrete

In cutting of concrete, the decisive criterion is not the lance heat, but the iron oxides produced in the consumption of the steel tube. The molten concrete, normally visous, becomes highly fluid through silicate formation, and the oxygen pressure facilitates ejection of the fluid lava from the pierce hole. There is no risk of damage to the surrounding core concrete because of poor thermal conductivity in the concrete, and the formation of an insulating slag ring of around 1 mm thickness. Temperatures at the backside of this ring are only as high as approx. 240°C. Moreover, the main part of the generated heat is removed with the ejected lava. Reinforced concrete is just as easy to pierce. The additional heat of combustion even promotes hole piercing. An increase in the lance temperatures can be obtained by aluminium wires packed into the tube. A maximum of 20% at the core must not be exceeded, however; otherwise the lance cannot be lighted any more.

Steel

Here, the packed wires are not essential for cutting purposes, steel itself disposes of sufficient iron for combustion. A tube to feed oxygen to the point of combustion is virtually sufficient. Two to three wires of 3 mm dia. Inserted in the tube facilitate reliable lighting. The application of an oxygen lance to pierce steel becomes more economical the thicker the material is. Results secured by tests are available for thicknesses of from 100 to 300 mm. The values obtained are summarised in a data sheet. As piercing steel is mainly used to produce a stab hole fro subsequent oxyfuel gas cutting, in most cases it has to be performed in a position perpendicular to the plate. In this case, particular attention has to be paid to slag removal. Slag must not be given a chance to flow back into the hole. The ejected slag, therefore, has to be blown off continuously. Slag sticking firmly around the pierced hole can be easily removed by using a hammer and chisel or appropriate machines. So far, there are no satisfactory results reported on parting compounds to prevent slag sticking.

The following equipment is required for oxygen lance cutting :
-Packed lances (commercially available)
-lance clamp
-oxygen supply with fittings and hose
-ignition source (welding torch)
-occupational safety facilities.

Consequently, the equipment is mobile, and can be set to work everywhere, quickly and easily.

The only consumables required are oxygen and lances. Strengths of this process are listed in the following table.

Specification-oxygen lancing

Lance lengths	-3, 4, and 6 m
Lance diameters	-1/4", 3/8", 1/2" and less
Sectional area ratio	-tube to wire to oxygen 1.2 : 1 : 0.7
Weight ratio	-tube 1 Core 1
Rate of feed	-350…800 mm7 min
Tube consumption	-consumption 4 6 Depth of hole 1 1
Ignition temperature	-1200°C
Melting temperature	-2000…2700°C
Oxygen pressure	-8…15 bar
Oxygen consumption	-approx. 650 l per m lance Rule of thumb : Oxygen, m3/h, equals 14 times the tube diameter in cm2
Concrete piercing	-1 m 3/8" lance melts 1 kg of concrete -1 m 3/8" lance consumes 272 l oxygen
Variations in practice	- Output reduced by 4% -oxygen consumption increased by 100%

To evidence economy, a true cost estimation is indispensable, preliminary trials may be advisable. Despite of lower economy in some cases, the benefits inherent to the process must not be underrated :

-Low noise level (only 70Db (A) in 10 m distance)
-vibrationless
-low dust level
-mobile
-bulky sections produced for ease of transportation.

A special disadvantage in concrete cutting is reported to be an elongation effect of heat in the reinforcing steel, which is said to cause the concrete to burst within a remarkable radius from the point of piercing. Since the coefficient of thermal expansion of steel nearly equals that of concrete, this impairment is out of question. To our knowledge, such damages have never been reported from practical use.

Safety

A few rules must be observed for safe handling of the lance. Since oxygen will support the combustion of any combustible material, rules and regulations for the use of oxygen must be closely observed. Sufficient ventilation must be provided at every work station.

The lances are to be kept free from oil and grease, in order to avoid violent reactions with oxygen.

Pressure regulators and hoses must meet Class B requirements covered in Standards DIN 8546 and DIN 8541, clamps shall preferably be made of brass, never of steel (DIN32510). Personal protective clothing shall be flame resistant, and shall cover the whole body. In addition, exhaust pipes for fumes and gases, and baffle plates against sparks are recommended.

Summary

Extensive investigations in theory and practice have proven that oxygen lancing is an efficient process for concrete and steel piercing. Especially for demolishing work it has captured a permanent share. It will open up further ranges of application, not least because of its environmental acceptability. Oxygen lancing can be used to pierce virtually all minerals and ferrous metals, every time and everywhere. Mobile use and ecological benefits are decisive advantages over competing processes. More recently, oxygen lance cutting has also been used underwater. This is a promising application in offshore technology.