Introduction
The substances in question are hydraulic, rolling and lubricating oils, and there are a number of conditions that are commonplace in the steel industry that can make these oils a significant fire and explosion risk.

The potential hazard from oil mists is recognized e.g. in the European ATEX Directive (directives concerning explosive atmospheres), but on their own, hydraulic and lubricating oils are not classified as Dangerous Substances under CLP as they have very high flashpoints, usually in excess of 200°C. Unless these oils are used in systems under high pressure (e.g. hydraulic systems), they tend to be omitted from consideration when assessing hazardous zones as part of the explosive atmospheres risk assessment process. However, as well as high pressure, other conditions can also make these oils a fire/explosion risk.

Hydraulic oils
Hydraulic oils are used in systems of high pressure, usually in excess of 100barg. A pinhole leak in a hydraulic system can result in the oil being forced through a small puncture or fracture in the pipework or connections (creating a “nozzle”), atomizing the oil with air and creating a flammable mist. In a rolling mill environment where these hydraulic systems run in close proximity to hot steel, or hot work welding or gas cutting, the possibility for the flammable mist to ignite is high.

An ATEX hazardous zoning exercise should identify this potential, and recommend a suitable zone around the hydraulic system. The Health & Safety Laboratory in the UK have published guidance this year that recommends this distance should be increased from 1m to 2.5m. However in practical terms, in a hot steel environment it may be impossible to effectively control ignition sources within this proposed zone of 2.5m.

Suitable alternative mitigation for this hazard could include spray or safety shields that are usually constructed out of a technical fabric or stainless steel that wrap around pipework or pipework connection, forming a physical barrier that prevents the formation of a mist if there is a failure.

Lubrication oils
Like hydraulic oils, rolling or lubrication oils also have high flashpoints, but as they are used in systems of low pressure (typically less than 10barg) these are often omitted from any ATEX or other fire/explosion risk assessment.

There have been some industrial explosions involving lubricating oils, where pressure vessels, such as air receivers or oil accumulators, have been over pressurised (internal explosion). There was an explosion in the Lackenby works in UK in 1984, the document written by a former HSE Inspector, D.B. Pratt on behalf of the Institute of Chemical Engineers describes this incident in some detail (please read The Fire and Explosion Hazards of Hydraulic Accumulators). However, hydraulic lubricators, such as the one involved in Lackenby are rare these days, but other vessels that use compressed air
over oil are still commonplace. These systems are designed to “drop” sufficient oil onto roller bearings of a steel mill if there is a loss of power to the lubrication pumps.

**Potential hazards of lube oil accumulators**

Lubrication oil that is used in these lubrication systems must be kept at an optimum temperature of approx. 35-55°C to allow efficient flow of oil around the system. It should be considered how these systems are heated, avoiding where possible internal heating elements in the accumulator itself. This is because, in the process of emptying these vessels, the surface of the oil can come into contact with a hot heating element, “boiling” the oil, and causing a rapid overpressure of the vessel. The pressure relief valve will be too small to relieve this pressure and an explosion results.

Another phenomenon that can create an explosive atmosphere within a lubrication system is known as “stripping”. Stripping occurs following the emptying of a lubrication system, where residual oil is present on the internal surface of pipework. As the compressed air circulates around the system, it “strips” particles of the oil forming an oil/air mist. This mist then has potential to ignite if it comes into contact with a suitably energetic ignition source.

Control of ignition sources is critical to maintaining the safe operations of lubrication systems. Even when these systems have been drained in preparation for maintenance work, residual oil on the internal surface of the pipework can atomise when heated locally (such as during hot work) potentially causing the atomised oil/air mist to explode. As well as controlling ignition sources, replacing compressed air with nitrogen or another inert gas would minimize the explosion risk.

**Conclusion**

More research is needed in the area of flammable mist formation involving high flashpoint fluids. The research of the Health & Safety Laboratory in the UK, led by Prof. Bowen at Cardiff University is helpful, but by its own admission this is just the starting point. The information that is available should be treated with caution, and operators in the steel industry should consider how the design and operation of their plants can create explosive atmospheres within their hydraulic and lubricating oil systems. This may require going over and above the minimum guidance laid down in regulations such as ATEX.

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