Information transparency for Industry 4.0

We were asked by a client, to provide a hitherto unseen picture of total speciality gas consumption, in a semiconductor fab, by converting and aggregating raw sensor data, captured from an existing SCADA system. How this was done and why this was done is explained in the case study below.

Background

Semiconductor device fabrication (in ‘fabs’) uses large quantities of speciality gases and chemicals in the manufacturing process (for etching, chemical vapour deposition, lithography, implantation, etc.).

Ultra-high purity, speciality gases are usually supplied in cylinders and dispensed via gas cabinets. Avoiding gas run-outs is critical (to maximise output of the fab and to any avoid scrap/rework) so the cylinder contents are closely monitored via pressure sensors (or weight sensors in the case of liquefied gases) often connected via controllers to a SCADA system. Often there may be hundreds of gas cabinets in a single fab and many cabinets may be used to dispense a single type of gas.

From dark data to useful information

The image in Fig 1 will be familiar to those who have responsibility for managing the supply of gases and chemicals in a semiconductor fab, the falling cylinder pressure trend is an indication that the cylinder is emptying over time.
What Fig 1 doesn’t show however is the amount (in terms of mass) of a particular gas consumed over time but also, more importantly, the amount of gas used to process a quantity of devices (i.e. specific gas consumption).

Significant variations in the amount of gas consumed may be an indication of an increase or decrease in production activity but it may also be an indication of a problem with the gas dispensing equipment, the gas distribution system and/or the manufacturing process.

Fig 2 has been derived from raw sensor data and it provides an indication of the total mass of a gas consumed on a daily basis (each point represents the amount of the gas consumed in a day).

A new picture for a new approach

Traditionally the primary focus of those responsible for managing the supply of gas and chemicals (which is sometimes outsourced to specialists) is on avoiding run-outs and miss-installs (a potentially very serious issue where a gas cylinder is installed in the wrong dispensing equipment) but with increased efforts to minimise costs on the behalf of the fab, there is greater interest in opportunities that might occur to minimise gas and chemicals consumption.

So why is this Industry 4.0?

Two key design principles of an Industry 4.0 solution are concerned with Information Transparency and Technical Assistance.
In the above case study Information Transparency i.e. ‘...the aggregation of raw sensor data to higher-value context information’ is provided by a cyber-physical system that converts individual cylinder pressure data into total mass consumption per unit of production information.

Whilst the same implementation facilitates Technical Assistance by providing ‘...an assistance system to support humans by aggregating and visualizing information comprehensibly for making informed decisions and solving urgent problems on short notice.’

How was this cyber-physical system configured?

An OPC application captures raw cylinder pressure data from an incumbent SCADA system which is then converted by an appropriate algorithm to mass consumption data and aggregated by gas type.

This daily mass consumption data is then presented graphically via an analytics platform with an email alert output that detects and notifies appropriate personnel when an unexpected level of consumption has occurred. Operators can annotate the data to explain these anomalies and over time this annotation provides a comprehensive explanation that can be used to inform for continuous improvement activity.