RETROFITTING COKE OVEN PRESSURE CONTROL WITHOUT STOPPING PRODUCTION[1]

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Abstract
With decreasing limits on allowable emissions on coke plants, one of the most effective emissions reductions strategies is single oven pressure control that allows the independent pressure control for each oven disregarding the collector main pressure set point. This strategy is known to greatly reduce, if not eliminate entirely, coke oven door, standpipe lid and filling port emissions by maintaining the collector main under negative pressure whilst maintaining a positive pressure in each oven throughout the carburization process.Paul Wurth has developed their Sopreco© (Single Oven PREssure COntrol) valve that allows the collector main to be kept at a negative pressure. The first generation Sopreco© Version 1 valve was internal to the collector main and was integral with the shut off valve (damper pan).
Key words: Emissions; Coke; Pressure.

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1 INTRODUCTION

The Sopreco© Version 1 was installed on a new coke battery of eighteen ovens in Fos-Sur-Mer and proven to work. The Sopreco© Version 1 valve controls the pressure in the coke oven by maintaining an annular gap between the specially shaped valve body and the collector main sleeve. At the start of coal distillation process the annular gap is relatively large and, as the gas produced reduces, the valve closes reducing the annular gap to main the correct set point pressure at the base of the standpipe. The annular gap is easily achievable on a new collector main installation but is more difficult to achieve on a retrofit into an existing collector main. This is due to the old collector main being distorted causing potential interference between the Sopreco© Version 1 and existing collector main sleeve. The location of the Sopreco© Version 1 on the damper pan is critical and with a new collector main would not present interference issues as would be the case with an older main.
Based on these disadvantages Paul Wurth decided to further investigate a different style of Sopreco© valve that would be totally external to the collector main and hence installation would be independent of the collector main condition (Figure 1).

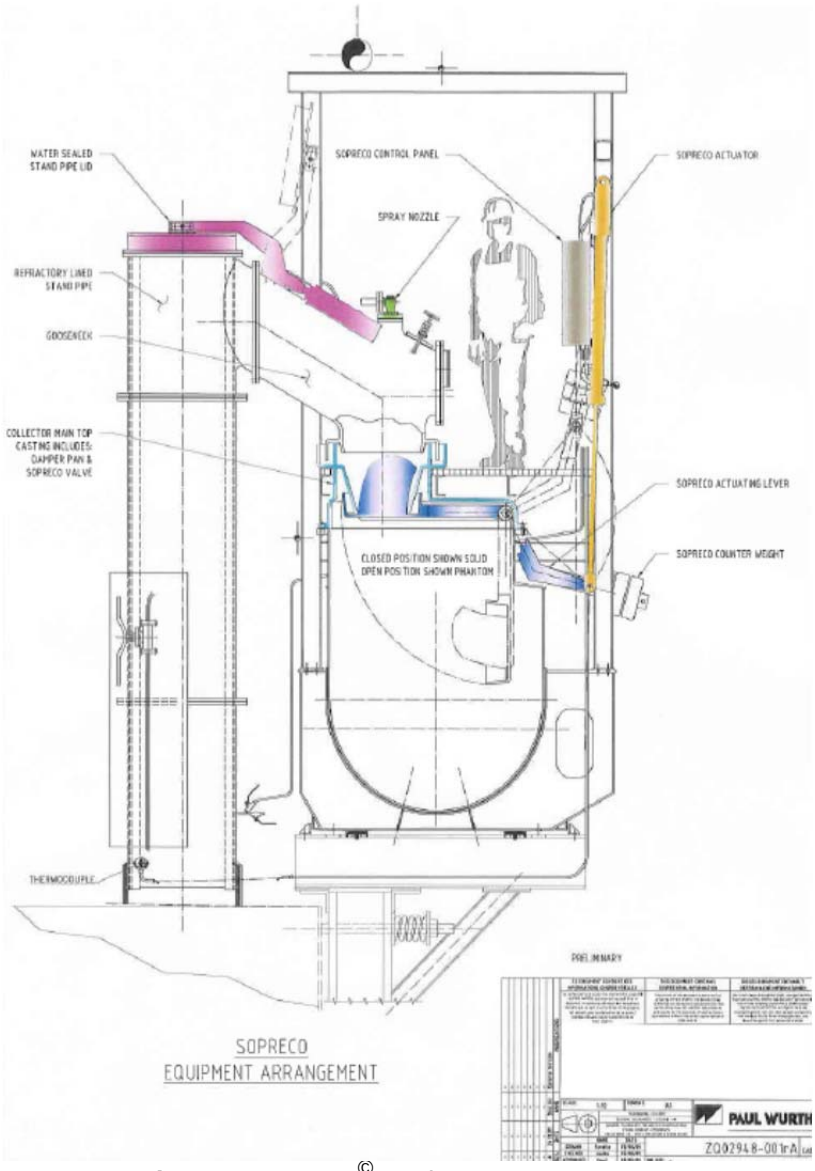

Figure 1. Sopreco© Equipment arrangement.

2 METHODOLOGY

2.1 Sopreco© Version 2 - Development

The development of Sopreco© Version 2 arose in conjunction with an order Paul Wurth received from Dillingen Hütte in January 2007. This order was for a stamp charged battery that required a negative collector main pressure of -50mm WG. The use of Sopreco© Version 1 for this negative pressure was investigated but it was decided to proceed with the development of Sopreco© Version.
Following the conceptual design, a test stand was erected (Figure 2) and testing was done to the satisfaction of Dillingen Hütte.

Figure 2. Test Facility in Luxembourg.

Following these successful tests it was decided to build three (3) valves for trial installation and testing (see Figure 3) on the existing No.2 Battery at Dillingen Hütte.

Figure 3. Sopreco© Version 2 ready for installation on Coke Battery No.2.

The installation on three adjacent ovens was done during normal operations after each oven was pushed empty. The standpipe and gooseneck were removed and replaced with a new assembly that included a longer standpipe and new fabricated gooseneck. The Sopreco© Version 2 valve was installed onto the shut off valve connection on top of the collector main. The upper section of Sopreco© Version 2 could have been made to match existing condition on the gooseneck but it was decided to fabricate new goosenecks that would match the new installation. This allowed the gooseneck to Sopreco© connection to be redesigned to be flanged. The lower part of the Sopreco© valve matched the existing connection on the collector main (Figure 4).

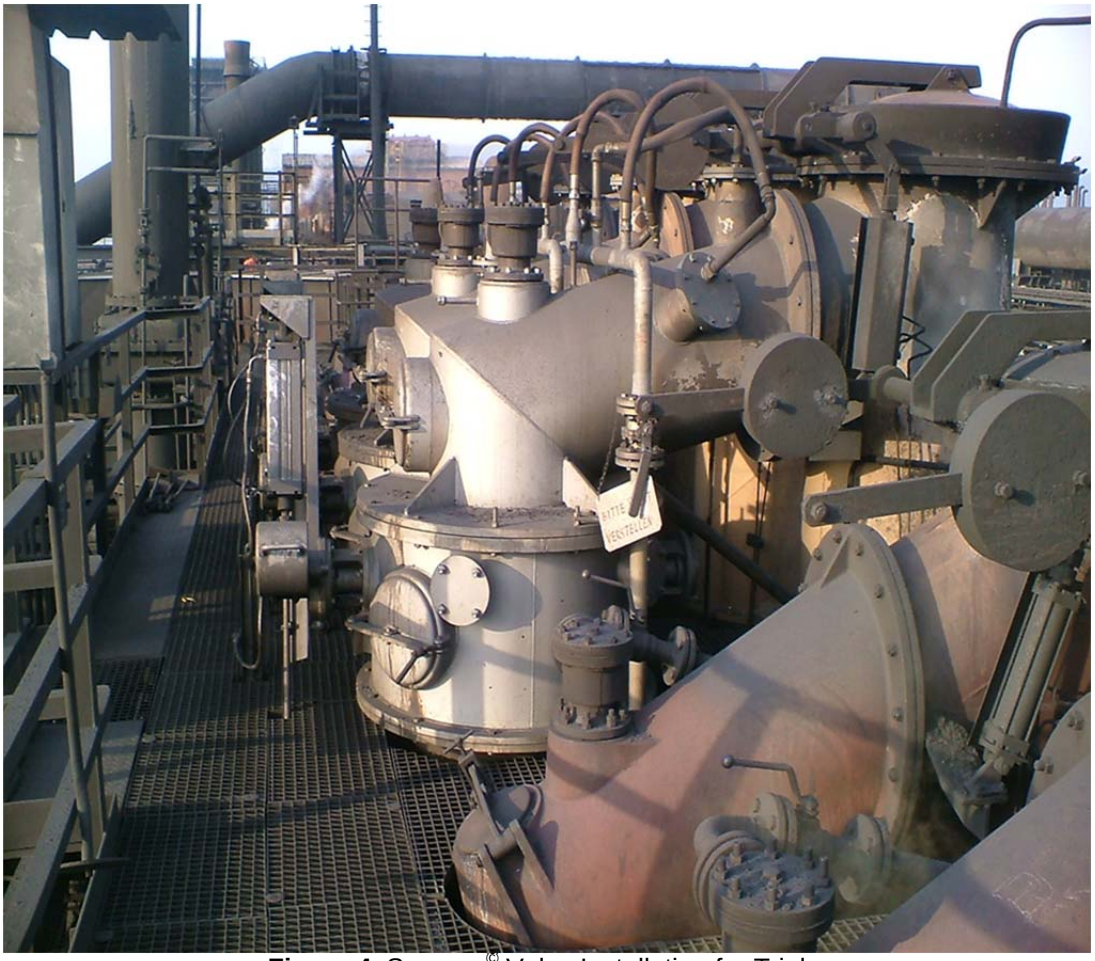

Figure 4. Sopreco© Valve Installation for Trials.

The control panel for testing the three Sopreco© valves was located close to the installed valves (Figure 5).

Figure 5. Control Panel for Sopreco© valve Trial.

3 RESULTS AND DISCUSSIONS

Trials on controlling each oven pressure were done over a period of months to prove that the system worked as designed to Dillingen Hütte's satisfaction. In consequence of the good test results of the three Sopreco© Version 2 test valves on Battery No.2, Dillingen Hütte agreed to equip the new Coke Battery No.3 and the rebuild of Coke Battery No.1 with Sopreco© Version 2 valves (Figure 6) , a total of 90 Sopreco© valves. The first 50 Sopreco© valves have been in operations since February 2010 on Battery No.3 and the other 40 have been in operation since October 2012 on Coke Battery No.1.

Table 1. List of valves ordered/in operation

PAUL WURTH: SOPRECO - Single Oven PREssure Control system					
Customer	**Battery**	**Charging system**	**Oven height**	**Battery start-up**	**Ovens n°**
AM - FR	Battery Nr. 3	Top charging	7,6	Jul-06	**18**
ZKS - DE	Battery Nr. 3	Stamp charging	6,25 m.	Feb-10	**50**
ZKS - DE	Battery Nr.1	Stamp charging	6,25 m.	Oct-12	**40**
BSL - IN	Battery Nr. 1/2	Top charging	7,6 m.	Sept 2013/Oct 2015	**74**
BPSL - IN	Battery Nr. 1/2	Stamp charging	5,5 m.	Sept 2014/Dec 2014	**94**
CSP - BR	Battery Nr. 1/2	Top charging	7,6 m.	Jan-15	**100**
Przyjazn - PL		Stamp charging	5,6 m.	Dec-14	**74**
Gunung - ID	Battery Nr.1	Stamp charging	5,5 m.	Oct-15	**66**
ILVA - IT	Batteries Nr. 7/8	Top charging	6,5 m.	Dec-13	**86**
				Total	**602**

Figure 6. Installation on the New Battery.

3.1 Continuing Investigation

The installation of the three test valves at Dillingen Hütte proved that the Sopreco© Version 2 valve can be easily retrofit one oven at a time on their collector main. Further investigations were done for two different collector main configurations to further confirm that the Sopreco© Version 2 valve could be retrofit in other plants (Figures 7 and 8).

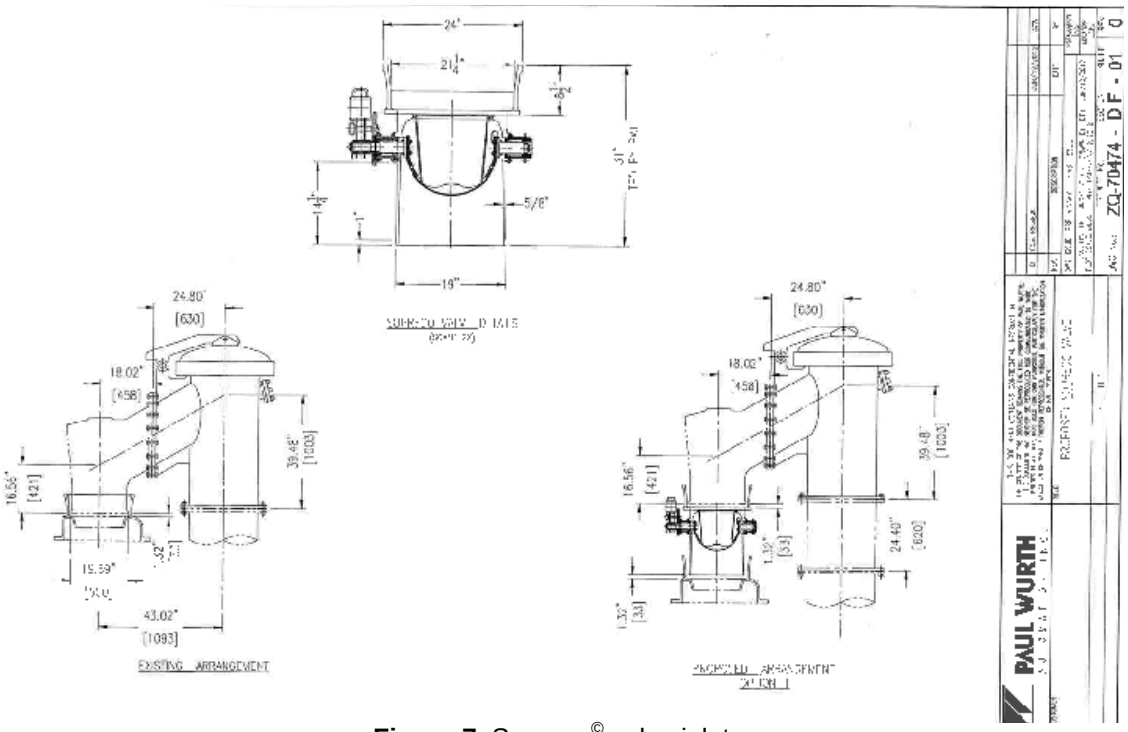

Figure 7. Sopreco© valve inlet.

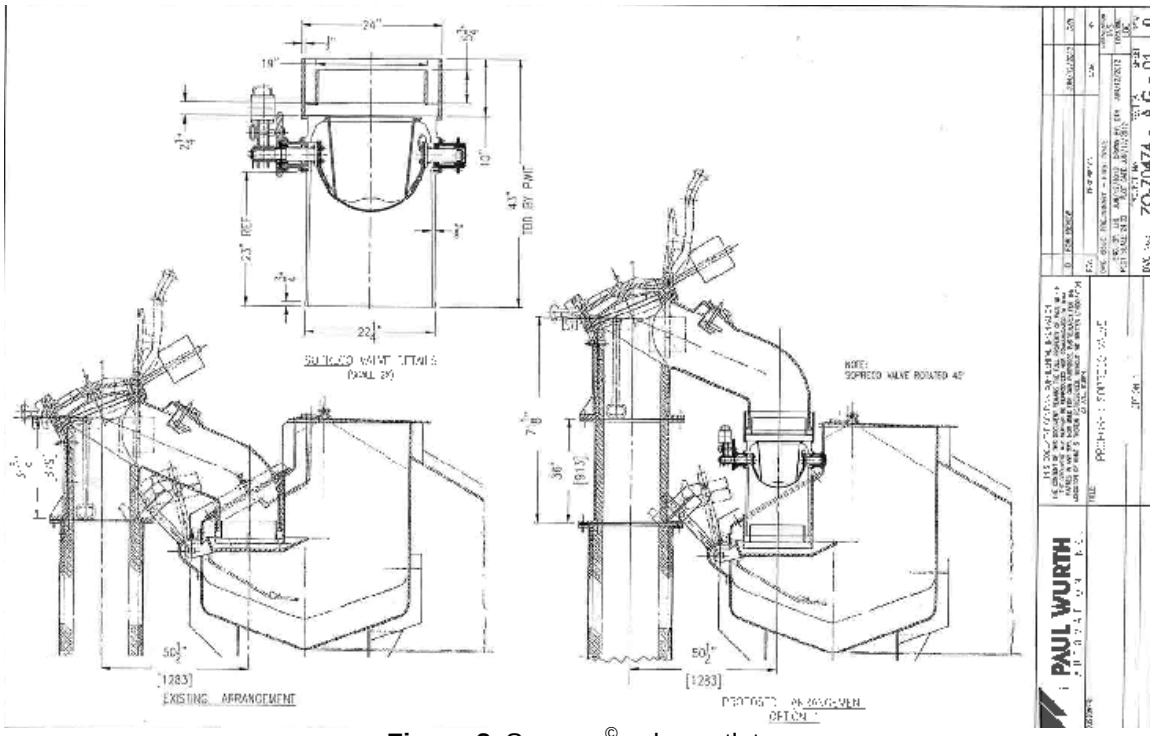

Figure 8. Sopreco© valve outlet.

In both the above examples the Sopreco© valve inlet and outlet (Figures 7 and 8) imitates the existing situation such that:

- the Sopreco© valve inlet is the same as the connection on the collector main;
- the Sopreco© valve outlet is the same as the bottom of the gooseneck.

There will be situations where space is just not available between the collector main connection and the standpipe and this is especially the case if the gooseneck connection leaves the collector main at an angle on smaller oven batteries. In this case new goosenecks are necessary.
Pneumatic actuators were used at Dillingen Hütte but other types of actuators, such as electro-mechanical, electrical rotary actuators etc can be used based upon each different plants preference.
On installations that have double collector mains PW would carry out feasibility tests to eliminate one of the collectors, by verifying the pressure losses from the battery to the BPP area. Any charging issues such as:

- sequence of coal flow;
- speed during charging or;
- size of the raw gas channel.

Can be also easily resolved due to the experience of PW in process and Coke Oven Machines area.

3.2 Sequence of Installation

When considering retrofitting the Sopreco© valves, all infrastructure and utility work can be completed with minimal, if any, interruption to operations and can be done either before or during the installation of the Sopreco© valves depending on schedule. The infrastructure work may include:

- collector main walkway modifications;
- electrical/instrument cabling installation;
- any modifications required to existing installations such as liquor piping, standpipe water cooled lid piping etc.;
- installation of instrumentation such as the pressure probe in the standpipe base;
- mounting of panels;
- modifications to the charge car for access to gooseneck cleaning.

Each oven is retrofit with a Sopreco© Version 2 valve during normal operation after the oven has been pushed empty and before being recharged with coal. This will require a refractory lined spool piece to be installed in the standpipe, installation of the Sopreco© valve and gooseneck. After installation the valve will be left in the open position until the total system has been installed and is ready for commissioning.
The installation of the valves has to be closely coordinated with operations to ensure that all the correct lockouts are completed before any crane lifts etc are allowed. Also the work on the battery top has to be closely supervised due to moving equipment. The installation time of the Sopreco© system is greatly dependent upon the battery operations but there is no detrimental effect to the equipment if the installation is done over a “long” period of time. It is important that the flushing liquor system be maintained to keep the internal Sopreco© valve components clean.
The commissioning of the Sopreco© system is relatively straight forward as was proven on the latest commissioning of the new Dillingen No.1 Battery. All systems were tested and operational in one week.

4 CONCLUSIONS

The Sopreco© Version 2 valve was developed for and is successfully operating in Dillingen and elsewhere.
Three sets of valves were installed on the old operating battery for testing purposes without having to modify the existing collecting main. Therefore the only loss of production during installation was the delay in charging while the new equipment is installed for each oven. The production of the rest of the battery was not interrupted.
The Sopreco© valves are “fail open” therefore, on a retrofit of an existing installation, each oven can produce as per the usual practice after the Sopreco© valve installation and before the system is put into operation. Only after all ovens have been retrofit, and PLC tested, the full battery can start operating with the new control logic.