CASE STUDY

Elspec EQUALIZER Corrects Metal Stamping Power Fluctuations

A large automotive metal stamping plant in the United Kingdom processes thousands of tons of sheet metal each year to supply door and side panels, hoods and chassis parts to its manufacturing and assembly plants throughout Europe. The stamping plant consists of eight automated transfer press lines and associated machinery such as conveyers, handling machines and scrap process. Each press line, similiar to that shown in Figure 1, stamps components for a different vehicle model and has its own dedicated supply transformer operating at three phase 415V, 50Hz.

Figure 1: Typical Automotive Metal Stamping Line

Stamping machines generate high levels of real power (kW) and reactive power (kVAr) consumption during their normal operating sequence. Power consumption is controlled by three main variables: the downward pressure that needs to be applied to the sheet metal being processed, the grade (thickness) of the steel, and the upward pressure required to release the stamping die from the block. Multiple press lines operating in the same location may cause serious disturbances on the electrical network, which may affect other manufacturing processes within the plant. Furthermore, these disturbances may affect other consumers who share the same local electrical distribution infrastructure.

Problem

Continuous and simultaneous operation of all press lines in this particular installation resulted in high reactive power and apparent power (kVA) consumption. This continuous large power consumption created transformer overloads and over-heating. The presence of harmonic distortion contributed to further heating and meant that some transformers were operating above 100ºC.

The press line idles at a very low load level, less than 10kW per phase; however, when the stamping process begins, the power levels fluctuate dramatically. Typically the load increases from less than 10kW per phase to 400kW to 420kW per phase within three to four cycles (60ms to 80ms at 50Hz, 50ms to 67ms at 60Hz). Peak consumption is then maintained for 4s to 5s. The dynamic load fluctuations re-occur continuously every 7s to 8s during a normal stamping run.

Figure 2 shows a 2min sample that graphically depicts a typical power profile of a normal batch process on the press line. The graph demonstrates that power consumption fluctuates dynamically, with reactive power varying by as much as 650kVAr for each stamping cycle. Ultimately, these reactive power fluctuations result in unacceptable degrees of voltage sag and high energy consumption. Eliminating or reducing these reactive power demand peaks is essential if voltage stability is to be attained.

The Elspec Solution

The Elspec EQUALIZER system is specifically designed to compensate for this type of dynamic load with high reactive power consumption. The EQUALIZER uses SCR-SCR (silicon-controlled rectifier) electronic switches and sophisticated control algorithms that consider true power factor (PF) and all harmonics up to and including the 63rd harmonic order. It calculates and responds to reactive power demand within less than one network cycle (<20ms at 50Hz, <16.7ms at 60Hz). In this application, a system rated at 785kVAr was installed directly at the press line transformer. It consisted of

In This Document

Read how the Elspec EQUALIZER:

- Reduces load current on each press line nearly 50% (from 1150A to <570A)
- Increases average voltage on each transformer by approximately 2.5% (10V), increasing utilization
- Reduces reactive power consumption from 245kVAr per phase to <50kVAr, improving power factor to an average of >0.95
- Decreases maximum apparent power demand by over 45% (from 840kVA to <450kVA)

six 131kVAr capacitor groups tuned to the 4.7th harmonic to reduce the impact of the 5th harmonic during peak demand.

Figure 3 shows that the EQUALIZER reduced apparent power consumption by nearly 50%. The average 3 phase voltage also shows an improvement of +2.5%.

Harmonic Mitigation

The press line's speed and process controls generate relatively high levels of harmonic current distortion. This harmonic distortion is a major contributor to the supply transformer's high operating temperatures. Although the main contributing harmonic is the 5th (H5), the overload of the supply transformer results in the amplification of all harmonics recorded, up to and including the 31st order.

Figure 4 illustrates the measured harmonic spectrum recorded during peak load conditions both before and after the EQUALIZER was installed. It is clear that harmonic currents are present at nearly every frequency up to and including the 31st order, although the intensity at higher orders is lower in comparison.

When all harmonic currents are taken into account in conjunction with the fundamental current, these press lines have a low PF, meaning there is significantly more current flowing in the stamping plant's power system than is needed. Increased current may also lead to higher cabling losses per kW of connected load.

The EQUALIZER successfully reduced the harmonic impact of not only the targeted 5th harmonic current, but also effectively lowered the harmonic current on each harmonic order. Figure 5, an enlarged view of Figure 4, offers a clear picture of the degree of harmonic mitigation achieved during the press line's peak operating conditions.

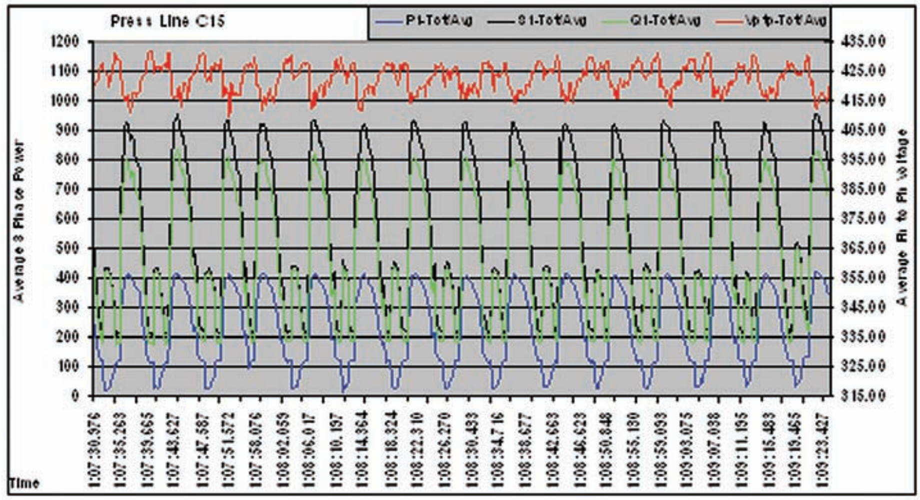

Figure 2: Press Line Power Profile (2Min Sample)

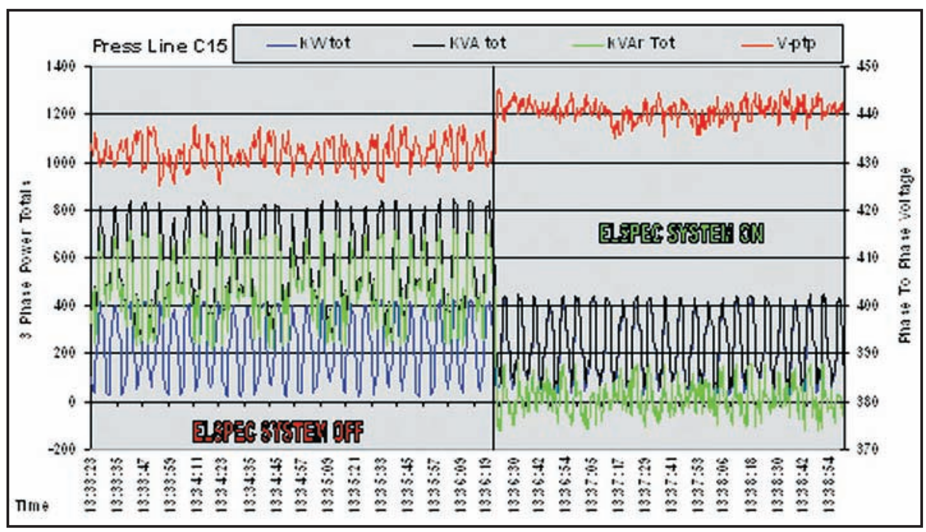

Figure 3: Press Line Power Profile Before and After EQUALIZER Installation

Figure 5 shows that the EQUALIZER has mitigated all significant positive and negative sequence harmonic currents. The fifth harmonic, potentially the most damaging, has been reduced from 167A to only 55A, a dramatic reduction of nearly 70%.

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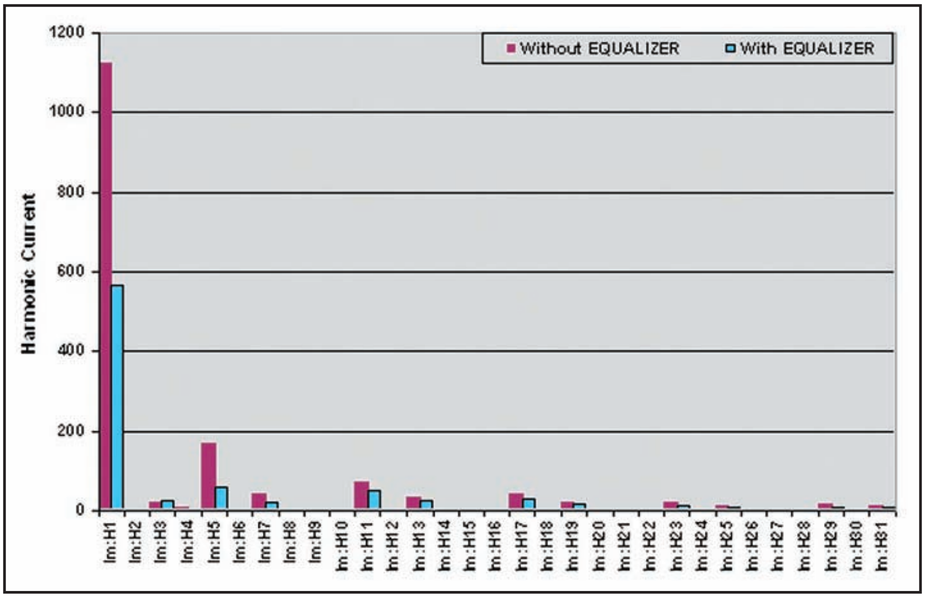

Figure 4: Harmonic Current Reduction

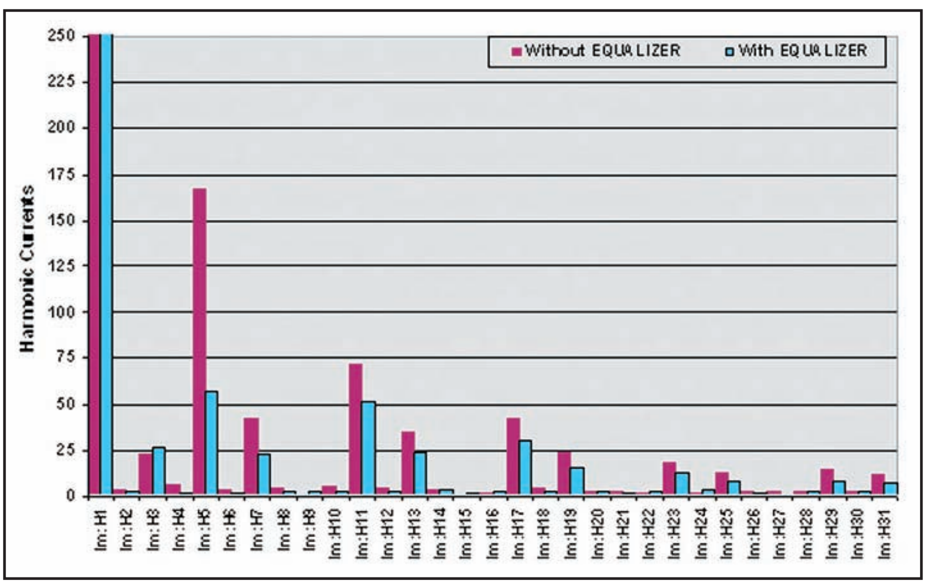

Figure 5: Harmonic Current Reduction (Enlarged View of Figure 4)

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