Further discussion: Inductive reactance, and the operation of large submerged-arc furnaces*

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As you pointed out, furnace power factor (and consequently transformer MVA rating) depends upon the inductive reactance, and so it is desirable to design for the lowest possible value of this parameter. The further introduction on the primary side of the transformer of capacitors, whether in shunt or in series, increases the network power factor but does not alter the furnace power factor; that is, the phase angle between electrode-to-hearth voltage and current remains unchanged. Thus, I find it difficult to equate the effect of series capacitors on the inductive reactance with that of reducing the magnitude of the latter physically or employing low-frequency a.c.

I would like to take this opportunity of congratulating you on an excellent paper, which I found most interesting.

Authors' Reply

Again we must emphasize that the major problems with large submerged-arc furnaces arise because the circuit is three-phase and not single-phase. For a balanced furnace, you are correct in saying that the power factor in each phase of the furnace as such (that is, the part of the circuit containing the inductance and the reactance) will not be significantly affected by the capacitors on the supply, whether the capacitors are in series or parallel. However, one must not forget that, in the case of a series capacitor, the supply voltage is first dropped across the capacitor before it reaches the furnace. This means that the supply to the furnace as such will vary depending on the magnitudes and phases of the currents that are drawn. This is particularly important in the three-phase system when the furnace is unbalanced, because then the voltages across the capacitors are neither equal nor symmetrical. Thus, another way of looking at series capacitors is that they modify the voltages fed to the furnace in such a way as to counteract the effects of the inductive reactances in the furnace. This is achieved by modification of the phase and amplitude relationships between the voltages and the currents in the circuit. One must be very careful not to consider the furnace simply as three single phases in isolation.

With respect to equating the effect of series capacitors on the inductive reactance with that of physically reducing the inductive reactance, one must realize that, while at 50 Hz the inductive and capacitative reactances do partially cancel each other and thereby reduce reactance problems, this does not mean that the use of series capacitors is not without other problems. Where it is possible, it is obviously better to physically reduce the inductive reactance of a furnace, but this might not always be possible, as is the case with very large furnaces.

Finally, we would like to point out that the use of series capacitors is not the only way to attack reactance problems. The National Institute for Metallurgy has developed a microprocessor-based electrode controller for submerged-arc furnaces that largely overcomes the problems caused by reactance. It works, not by reducing the reactance, but by correctly allowing for it in the control of the furnace.

J. Meintjes

I would like to know more about the electrode controller developed by NIM, and whether it is available for industrial use. Perhaps you would be kind enough to let me know at your convenience.

Authors' Reply

The technology for the production of the electrode controller has been transferred to Siemens Limited, who will produce these units as the sole licensee.

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Corrigenda

The following amendments should be made to the article entitled 'Coal-preparation routes for maximum coal recovery', which was published in the August issue (vol. 80, no. 8) of this *Journal:* Page 271, footnote. *Welmet* should read *Velmet*. Page 277. In the first line of the text on that page, (*Fig. 7*) should read (*Fig. 6*).