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doi:10.15199/48.2016.06.29

# Accurate CPC Power Analysis under Extreme EAF's Distortion Conditions

***Abstract**. Electric Arc Furnaces (EAF) are huge energy consumer. However due a limited power calculation the maximum electrical efficiency is not obtained. Most of the applications in market report the usage of inaccurate power quantities in EAF power control system. Because the extreme distortion conditions of power phenomena produced by the nonlinearity of the load in the EAF, the implementation of Current's Physical Components (CPC) power theory has the potential of describing more appropriate than traditional power theories the physical load conditions and the electric power phenomenon during the Heat Process. Each one of the current components proposed by CPC offer useful information of the load condition, and give indicators which can be useful as stability indicators of the process for a better identification of the EAF stage.*

***Streszczenie.** Piece łukowe rzadko osiągają maksymalną skuteczność. Zastosowanie metody Current Physical Component pozwala bardziej dokładnie analizować warunki obciążenia podczas wyładowania i tym samym osiągać mniejsze zniekształcenia i lepszą skuteczność. **Dokładna analiza pieców łukowych przy znaczącym zniekształceniu napięcia metodą CPC***

**Keywords:** Electric Arc Furnace, Non-Sinusoidal Signals, CPC Power Theory.
**Słowa kluczowe:** piece łukowe, zniekształcenie napięcia, teoria CPC.

## Introduction.

Electric Energy has been a global concern from the middle of the past century up to date. Reduction in no-renewable resources, increase in pollution and increase in oil and gas prices are some of the factors that have turned energy efficiency into a determinant factor for the economic development of countries in the last years. Electrical efficiency has turned a key aspect for industry, utilities, governments and environment. In [1] the International Energy Agency (IEA) states that energy improvements on a global scale could save between 25 EJ and 37 EJ of energy per year (1.9 Gt of CO2 to 3.2 Gt of CO2 emissions per year), which represents 18% to 26% of current primary energy use in industry.

According to [1] the largest savings potentials can be found in the iron and steel, cement, and chemical and petrochemical sectors. The iron and steel sector is the second largest industrial user of energy, consuming 23 EJ in 2005. This way, the research in iron and steel sector represent a potential opportunity to achieve electrical efficiency improvements. However the direction that must be taken to reduce energy consumption is the application of new technologies, best practices and break to paradigms in energy efficiency field. An Electric Arc Furnace (EAF) is an industrial device used for steel production. The actual energy used in the EAFs depends from the quality and conditions of the charge materials (scrap, DRI and others), the amount of slag and the total time of the heat. EAF facilities contribute to a great proportion (estimated to be 31%) of the world´s steel production [2]. EAFs are very huge electrical loads ranging from several MVA up to 250 MVA in modern facilities. Therefore, considering these amounts of power, it is relevant to study and analyze the EAF electrical circuit since small improvement and increment in energy efficiency represent significant KWh of energy savings. Electrical energy consumption in EAF is a stochastic process which has certain a-periodicity which changes cycle by cycle what increases highly the voltage and current distortion in magnitude phase and frequency. Most of the applications in market [3-4] report the analysis of the EAF electrical system considering traditional power indicators. However have been demonstrated [5-6] that power theories that were part of IEEE Std. 280-1985, and IEEE Std. 100-1996 [7-8] in the last century are only valid under sinusoidal and balanced conditions of voltage and current signals.

Under extreme voltage and current distortion conditions, similar to those produced by electric arc loads, there is not a particular or a defined power theory oriented to give useful power indicators for indentifying special conditions or power phenomena. In order to contribute to the analysis of arc furnaces under extreme distortion condition this paper proposes the implementation of Current's Physical Components (CPC) power theory considering the harmonic distortion and asymmetry of voltages and current signals found at EAF's facility. In addition in this paper it is presented a study case where are analyzed with the CPC 3-phase 3-wire voltage and current signals gotten from field measurement. The scope of this analysis is the comparison of one 60 Hz cycle of Bore-Down stage against one 60 Hz cycle of refining stage.

## Electric arc furnace Features.

The current drawn by the EAF depends of the physical composition of the scrap to be melted, which changes long the EAF process what causes that the apparent power $S$ varies depending on the heat stage. Since the arc is extinguished at current zero the power factor plays an important role on arc re-ignition to ensure stable operation. Therefore, it implies a relatively low power factor, at least during Bore-Down stage. In an EAF the Heat Process is composed of melting the loaded scrap and refining the molten steel, it has three stages: Bore-Down, Melting and Refining [9]. From the three stages Bore-Down is the stage with the highest distortion, as scrap metal is recently added to fill up the furnace and the load presents a lot of heterogeneity. In Melting stage a bigger cavity in the middle of the scrap is achieved the electric arc touches the lined shell base then it becomes more stable, but due to the solid scrap that has not molten yet, the current characteristic is still unstable and with random behaviour. The final heat stage is Refining. This is the most stable of all of three stages; in this the whole scrap material in the EAF is liquid. The homogeneity of the load in this stage makes that arc length more stable.

A simplified EAF's model of the electrical circuit is proposed by Bowman and Kruger in [10]. This circuit considers from the transformer secondary side toward the load. The secondary transformer is ungrounded because the load in this case furnace shell must be grounded. It is usual that in AC EAF installation secondary delta transformer be used for that. In Fig.1, $X_{pri}$ and $R_{pri}$ represents the source (primary circuit) impedance, $R_{fce}$ and

$X_{fce}$ represent the short circuit (line) parameters of the transformer and furnace impedances (cables, arms and electrodes) values, $R_{arc}$ and $X_{arc}$ represent the arc resistance and reactance.

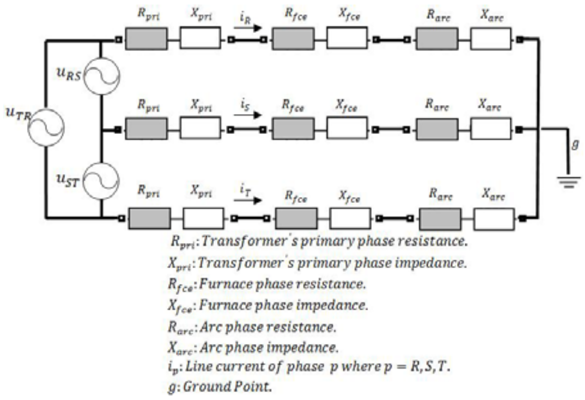


Fig.1 Common electric circuit found in EAF's installation.

In order to calculate EAF's power parameters it is necessary to have real-time measurements of the voltage and current waveforms in order to perform online time domain calculations and Fast Fourier Transforms (FFT), the Root Mean Square (RMS) values and total harmonic distortion (THD) of voltage and current as these are used for arc regulation. In some EAF power control systems, the arc stability correlated with THD values is a relevant process variable, useful to define operational points in power (transformer and reactor taps selection as well as current set points)[10]. Most of the applications in market oriented to the control of the different EAF subsystems report the usage of static power profiles in the EAF's power control system [11]. The power profile is used for getting power and electrical indicators data. These data are converted in set points for the power control system (transformer tap set point) or in data that are passed as set points to the electrodes control system (current/impedance set points) for the arc regulation control.

In order to increase the EAF energy efficiency different research approaches have been taken, most of them focused in the Arc Regulation System where different control algorithm and novel control strategies as Fuzzy Logic and Neural Networks are reported to be used. However despite that the EAF high distortion conditions there are only a reduced number of publications in academy that consider the power control improvement and report the usage of non-sinusoidal power theories in EAF study.

**The Advantages of CPC in EAF.**

Because the extreme distortion conditions and the EAF operation needs, some particular electric phenomena are produced in EAF electric circuit. A very close condition to short circuit is the operative base of EAF what is responsible of some power quality problems which are reflected in the electrical installation. For instance despite that the EAF is supplied with periodic symmetrical sinusoidal voltage signals, the nature of the electric arc and the changes in the load produce a high distortion in harmonic, phase, magnitude and period in this voltage signals. This is because a phenomenon of randomly discharge is present during the EAF operation as a result of the chaotic nature of the electrical non-linear load formed between the electrodes and scrap metals. The EAF nonlinearity causes voltage harmonic in electrical distribution network due to the large and random variation of the reactive power drawn from the source. This way, as the arc behaves as a non-linear resistance it causes that not characteristics harmonics being generated in the load and flow back from the load to the voltage supply transformer. This way the EAF behaves as a Harmonic Generating Loads (HGL´s) [14-16].

The particular EAF electric features mentioned make evident that in order to increase electrical efficiency in EAF it is necessary to have a complete understanding of the power phenomenon under non-sinusoidal conditions. The implementation of power theories that consider non-sinusoidal conditions is an important opportunity to get more information of the power properties of the EAF which can be useful to increase the electrical efficiency in this very particular kind of loads. A better analysis can be done and more information can be gotten considering the non-sinusoidal conditions of the EAF.

Harmonic distortion, impedance unbalance, load generated harmonic, voltage fluctuation, open and short circuit, lagging power factor are some of the phenomena that are present long the EAF Heat Process. These phenomena affect the energy transfer and efficiency in EAF as these don't increase the active power $P$. Each one of these non-active powers is related directly with the furnace´s load composition or the electrical circuit behaviour. In order to improve energy efficiency it is necessary to identify and quantify if possible each one of these different effects.

Traditional power theories found in Standard 519-1992 or in Standard 1159-1995 [7-8] only offer the possibility of calculating and separating Apparent Power in Active Power, Reactive Power and Distortion Power what not cover totally the understanding of the EAF power phenomena. In this way, with the objective of achieve a most complete understanding of the EAF power properties this paper proposed the application of Current's Physical Component (CPC) power theory [17-19] for the EAF power analysis. The information that can be gotten with each one of the 5 Current's components proposed by CPC theory in three-phase three-wire systems can be related with some of the physical phenomenon that occur in the EAF electric circuit along the Heat Process. The CPC let us to calculate, analyze and quantify some of these phenomena and can reflects the characteristics of EAF loads more accurate. Fig. 2 shows a diagram of the EAF main control modules found in typical installations, in this diagram the Power Control System, Arc Regulation System and the Electrode Control System are shown, in addition in the diagram is included the analysis proposed of the EAF electric parameters by the implementation of CPC power theory in order to complement the information that is processed by the power control module.

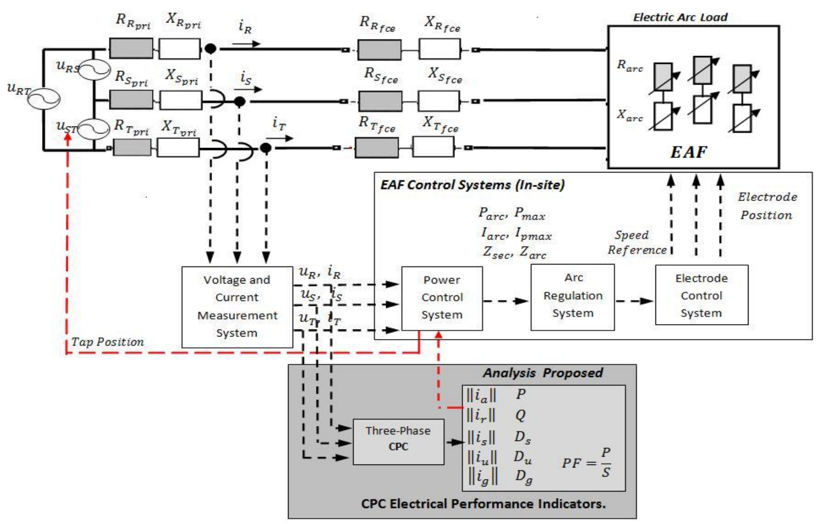


Fig.2 Basic EAF control subsystems and CPC analysis.

In CPC for three-phase three-wire systems each one of the five current components is associated, separately, with distinctive physical phenomena in the circuit: Active current $\|\boldsymbol{i}_a\|$ with the permanent energy transfer to the load, Reactive Current $\|\boldsymbol{i}_r\|$ with current phase shift with respect to the supply voltage. Unbalance Current $\|\boldsymbol{i}_u\|$ supply current asymmetry due to the load unbalance. Scattering Current $\|\boldsymbol{i}_s\|$ occurs in the load supply current when the load equivalent conductance $G_{en}$ changes with harmonic order. Generated Current $\|\boldsymbol{i}_C\|$ is associated with the harmonic generated by HGL loads. The five currents are orthogonal (6), the RMS values of each one of these currents is shown from (1) to (5).

(1) $$\|\boldsymbol{i}_a\| = G_e\|\boldsymbol{u}\|$$

(2) $$\|\boldsymbol{i}_s\| = \sqrt{\sum_{n\in Nu}(G_{ne} - G_e)^2\|\boldsymbol{u}_n\|^2}$$

(3) $$\|\boldsymbol{i}_r\| = \sqrt{\sum_{n\in Nu} B_{ne}^2\|\boldsymbol{u}_n\|^2}$$

(4) $$\|\boldsymbol{i}_u\| = \sqrt{\sum_{n\in N} A_n^2\|\boldsymbol{u}_n\|^2}$$

(5) $$\|\boldsymbol{i}_C\| = \sqrt{\sum_{n\epsilon N_C}\|\boldsymbol{i}_n\|^2}$$

(6) $$\boldsymbol{i}^2 = \|\boldsymbol{i}_a\|^2 + \|\boldsymbol{i}_s\|^2 + \|\boldsymbol{i}_r\|^2 + \|\boldsymbol{i}_u\|^2 + \|\boldsymbol{i}_C\|^2$$

**Analysis of the 5 CPC components.**

*Active current $\|\boldsymbol{i}_a\|$.*

The active current is the only current proposed by CPC that transfer useful energy to the load [17]. In the EAF, this current is the responsible of heat transfer in the arc, the three phase equivalent conductance $G_e$ is not related individually with harmonic content but it is a scalar indicator of how the EAF's three phase impedances behave.

*Reactive current $\|\boldsymbol{i}_r\|$.*

The reactive current in CPC is related with the phase shift between voltage and current signals. As it was mentioned in EAF, an option for power control are the power locus diagrams whose operating points are set at when the circuit resistance is equal to circuit reactance. This theoretically occurs when voltage and current are separated an angle of 45°. Reactive current $\|\boldsymbol{i}_r\|$ in CPC quantifies this behavior considering each harmonic equivalent suceptance $B_{en}$.

*Scattering current $\|\boldsymbol{i}_s\|$.*

In difference to THD, CPC relates $\|\boldsymbol{i}_s\|$ not only with the RMS value of the $n^{th}$ current harmonic order, as is done in THD, but it relates $\|\boldsymbol{i}_s\|$ with the amount of change produced by every harmonic with respect to $G_e$. This way $\|\boldsymbol{i}_s\|$ has the potential of describing the heating process better than the THD as the scattering current relates with the physical behavior of the load with each order harmonic.

*Unbalanced current $\|\boldsymbol{i}_u\|$.*

The changes in the EAF's electrode impedances unbalance constantly the load, what it means that CPC unbalance current is present in the EAF long the Heat Process. Because of the load behavior the unbalance in the EAF cannot be omitted, however in CPC, with the unbalance current $\|\boldsymbol{i}_u\|$ it can be calculated the ratio of the current that is produced specifically by the load unbalance and how this change during the Heat Process and measure how this is affected when there is a tap change.

*Generated current $\|\boldsymbol{i}_C\|$.*

The load generated harmonic current does not transfer useful energy to the circuit as these harmonics flow back to the system and are transformed into heat at the supply source resistance. The CPC theory identifies the harmonics generated by the customer loads by the generated current concept $i_C$ as in single-phase as in three-phase systems. In the same way that the rest of the CPC components the generated current is related with a physical phenomenon. It can serve as an indicator of how the load is changing its chemical phase from solid scrap into liquid steel.

**Study Case.**

In order to do an initial analysis of the proposed CPC processing and analysis of Fig. 5, a study case is presented. In this study case are analyzed 2 60 Hz cycles of three phase voltage and current signals, shown in Fig.5. The first of these cycles corresponds to the EAF's voltage and current signals during Bore-Down stage, the second one correspond to the voltage and current signals during refining stage. The data of voltage and current used for the analysis were gotten from a real EAF installation measured in field from the transformer used for instrumentation. In the CPC analysis the EAF is considered as an HGL load and the circuit is separated as it is indicated in [15] and [19] where the set of the harmonic $N$ is separated in Distribution system $N_D$ harmonic and Customer system harmonics $N_C$. For this separation the sign of the harmonic active current $I_{an}$ is analyzed according to (7) whose values are gotten from three-phase current FFT processing.

$$I_{an} \geq 0, then\ n\ \in\ N_D\ ,$$
$$I_{an} < 0, then\ n\ \in\ N_C\ ,$$

(7) $$I_{an} \triangleq I_{Rn}\cos\varphi_{Rn} + I_{Sn}\cos\varphi_{Sn} + I_{Tn}\cos\varphi_{Tn}$$

The subsets $N_D$ and $N_C$ don't contain common harmonic orders n, thus currents $i_D$ and $i_C$ are mutually orthogonal. It enables the next voltage and current decomposition into components with harmonics from sub-sets $N_D$ and $N_C$.

$$i = \sum_{n\in N} i_n = \sum_{n\in N_D} i_n + \sum_{n\in N_g} i_n \triangleq i_D + i_C$$

$$u = \sum_{n\in N} u_n = \sum_{n\in N_D} u_n + \sum_{n\in g} u_n \triangleq u_D - u_C$$

$$P = \sum_{n\in N} P_n = \sum_{n\in N_D} P_n + \sum_{n\in N_g} P_n \triangleq P_D - P_C$$

The subsets $N_D$ and $N_C$ don't contain common harmonic orders n, thus currents $i_D$ and $i_C$ are mutually orthogonal. Hence their RMS values satisfy the relationship: $\|i\|^2 = \|i_D\|^2 + \|i_C\|^2$ where $\|i_D\|^2 = \|i_a\|^2 + \|i_r\|^2 + \|i_s\|^2 + \|i_u\|^2$.

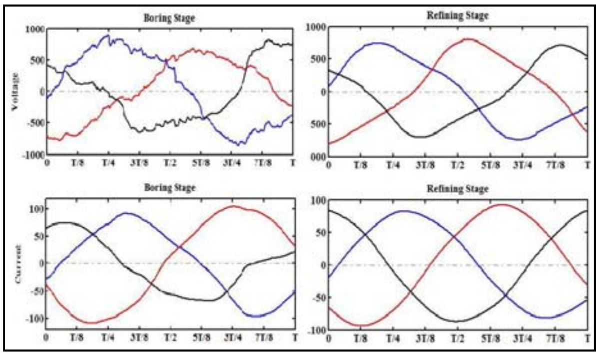


Fig. 3. Bore-Down and Refining Three-Phase Voltage and Current.

In Fig.3 it is shown the RMS values and the order of the current generated harmonics as for Bore-Down stage as for Refining stage. It can be observed how there is a wide spectrum of generated harmonics during Bore-Down. All of these harmonics don't supply useful power to the load. In Refining stage there still exits generated harmonic because the arc continues active, however the spectrum of generated harmonics is more reduced and in minor magnitude. Once the harmonic separation is done, each one of the CPC currents that corresponds to the distribution system are processed (1) to (5).

Fig.4 shows the harmonics that correspond to the reactive power $i_r$. As can be observed practically in the EAF the reactive power is caused by fundamental and by the second harmonic order. The RMS value of the fundamental is practically the same as in Bore-Down as in Refining stage this is because the phase shift between voltage and current exists long the Heat Process due to furnace reactance.

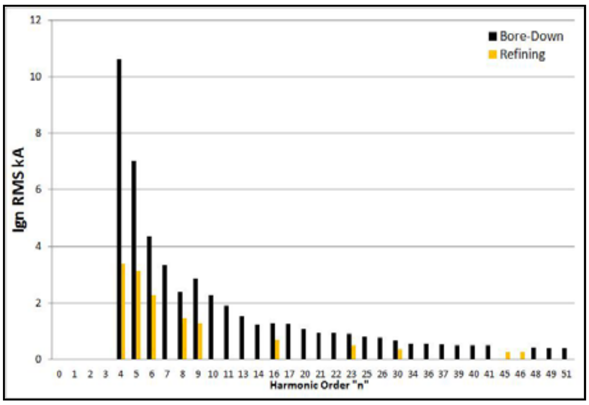


Fig.4 Generated current by harmonic order Bore-Down vs Refining.

In Fig.5 it is presented the harmonic behavior of the scattering current for Bore-Down and for Refining considering the difference $(G_{ne} - G_n)$[20]. During the analyzed cycle of the Bore-Down stage the scattering current is caused mainly by the DC offset, fundamental and second harmonic, there exist other harmonics however its magnitude is reduced in comparison, in refining stage the magnitude and the frequency spectrum are both reduced.

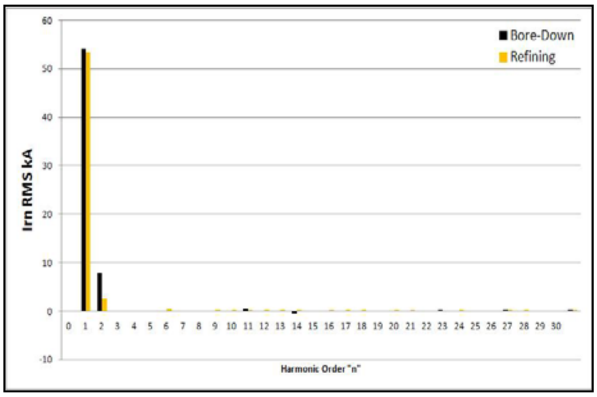


Fig. 5 Reactive current by harmonic order Bore-Down vs Refining.

In Fig.6 it is shown the harmonic spectrum of the unbalanced current. It can be observed that for Bore-Down stage unbalance is concentrated in fundamental and second order harmonic, there is also important unbalance in higher harmonic orders which is produced for the random load behavior; during Refining stage the unbalance remains in minor magnitude in fundamental and in second harmonic order. The RMS value of each one of the CPC currents is summarized in Table I as for Bore-Down as for Refining Stage analyzed. In order to verify the correct implementation of CPC theory it is calculated the RMS orthogonal current, considering each one of the CPC components in (8), and the RMS current**,** considering the harmonics of the three phase system currents (9).

(8) $$\|\boldsymbol{i}\| = \sqrt{\|\boldsymbol{i_a}\|^2 + \|\boldsymbol{i_r}\|^2 + \|\boldsymbol{i_s}\|^2 + \|\boldsymbol{i_u}\|^2 + \|\boldsymbol{i_g}\|^2}$$

(9) $$I = \sqrt{\sum_{n=0}^{N} \boldsymbol{I_n}^2}$$

As it can be observed each one of the values in Table I is much lower in Refining stage than in Bore-Down stage with exception of active and reactive current which are almost the same value in both stages. This is because generated current, scattering current and unbalanced current change with the scrap or liquid steel load composition.

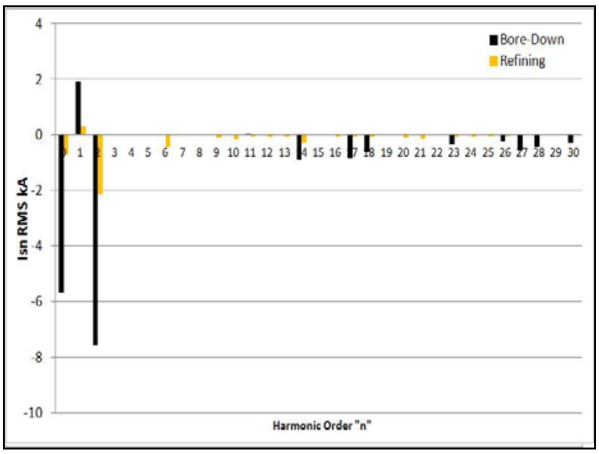


Fig. 6 Scattering current by harmonic order Bore-Down vs. Refining.

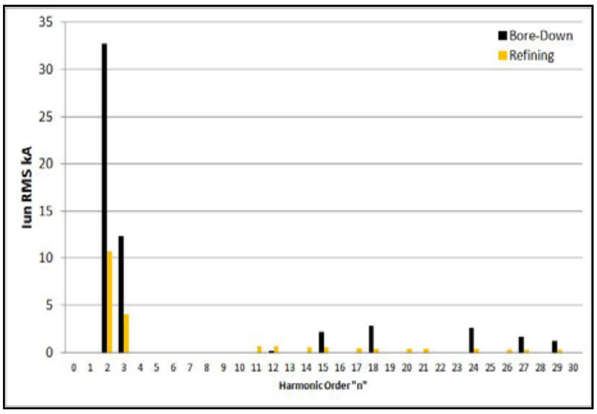


Fig. 7 Unbalance current by harmonic Bore-Down vs. Refining.

Table I. RMS value of CPC components.

| Current | Bore-Down kA | Refining kA |
|---|---|---|
| Active $\|\|\boldsymbol{i_a}\|\|$ | 88.73 | 91.05 |
| Reactive $\|\|\boldsymbol{i_r}\|\|$ | 54.67 | 53.38 |
| Scattering $\|\|\boldsymbol{i_s}\|\|$ | 9.89 | 2.37 |
| Unbalanced $\|\|\boldsymbol{i_u}\|\|$ | 35.92 | 11.5 |
| Generated $\|\|\boldsymbol{i_C}\|\|$ | 15.24 | 5.61 |
| $\|\|\boldsymbol{i_D}\|\|$ | 110.68 | 106.20 |
| $\|\|\boldsymbol{i_C}\|\|$ | 15.24 | 5.61 |
| $\|\|\boldsymbol{i}\|\|$ | 111.72 | 106.34 |
| $I$ | 111.67 | 106.37 |

(10) $$P = \sum_{n=1}^{\infty} U_n I_n cos\emptyset_n$$

(11) $$Q_B = \sum_{n=1}^{\infty} U_n I_n sin\emptyset_n$$

(12) $$D_B = \sqrt{S^2 - P^2 - {Q_B}^2}$$

Table II. Calculation of Power Indicators in EAF.

| **CPC Power Theory** | | | **Budeanu Power Theory** | | |
|---|---|---|---|---|---|
| *Power* | *Boring* | *Refining* | *Power* | *Boring* | *Refining* |
| *Active P(MW)* | 75.76 | 76.58 | *Active P(MW)* | 76.09 | 76.79 |
| *Reactive Q(MVA)* | 50.86 | 46.08 | *Reactive $Q_B$(MVA)* | 45.64 | 44.57 |
| *Scattering $D_s$(MVA)* | 10.73 | 6.33 | *Distortion $D_B$(MVA)* | 25.47 | 15.60 |
| *Unbalanced $D_u$(MVA)* | 31.31 | 9.76 | | | |
| *Generated $D_g$(MVA)* | 13.28 | 4.76 | | | |
| *Apparent(MVA)* | 97.97 | 90.26 | *Apparent(MVA)* | 92.32 | 90.15 |
| *S=I*\|\|u\|\|* | 97.49 | 90.67 | *S=\|\|i\|\|*\|\|u\|\|* | 97.49 | 90.67 |
| *PF* | 0.77 | 0.85 | *PF* | 0.82 | 0.85 |

In Table II it is presented the analysis of powers computed by CPC currents gotten from multiplication of each one of the CPC currents (1) to (5) by the three phase RMS voltage. It can be observed in Table II that active power $P$ is slightly increased in refining stage, however apparent power is reduced around 8MVA mainly by the considerable reduction of $D_s$, $D_u$ and $D_g$. Reactive Power $Q$ is also reduced however, in comparison with the others powers this is reduced in minor proportion. In Table II it is also presented the power analysis considering Budeanu power theory. Budeanu is the main power theory found in Standard 519-1992 or in Standard 1159-1995 [7-8]. Budeanu theory is based in powers calculation and it is according to (10) to (12). One aspect to mention is the difference in the amount of the apparent power; it can be observed how the quadrature sum of individual powers is very different to the apparent power gotten considering RMS voltage and RMS current multiplication. This inconsistency has been highlighted in [5, 6]. As it is observed in CPC the difference in apparent power calculation is much reduced. In addition, active power $P$ is slightly different in both calculations because in CPC some harmonics behaves as generated harmonics and these are part of generated power. This way information gotten with traditional power theory lacks of precision, since its values are more reduced than real values and in addition Budeanu power theory does not reflect totally the real EAF's behavior.

**CPC components as EAF's indexes.**

In EAF power control system some indexes are used with the objective of describe more accurate the Heat Process, increase energy efficiency, and be useful as indicators for process monitoring and control, some of these are: Stability Index, Coverage Index, Foaming Slag Index, Balance Index, among others. From the several indicators the more important for EAF is the arc stability, for steelmakers, arc stability is associated with the continuity of the current in the sense that the arc does not extinguish in time. Under this condition the current/voltage are reasonable symmetrical and high order harmonic content is low. Therefore, there is a need to control the electrical power for keeping the Heat Process with a minimum break in the arc and with unnecessary electrical power consumption. Arc Stability is a relevant process variable used to define set points in the control power system. If good arc stability is notified the power is increased, or it is decreased when it is in poor arc stability [23]. The objectives of such process are: to minimize the leakage of the electrical power and to improve the productivity. Therefore, an efficient control of the arc stability is an important factor to reduce the power loss and increase energy efficiency.

A common indicator used as index to quantify arc stability is the THD of the phase voltages. As the harmonic content of this voltage change long the Heat Process from higher THD in Bore-Down stage to final lowest THD during Refining stage. This way, in relation to harmonic distortion, the THD tries to describe the behavior of the load in EAF and is used as one indicator of the Heat Process as it is shown in [24,25]. However the THD has to be calculated and analyzed individually for each phase of the EAF circuit and its usage has some limits. For that reason research for finding better EAF's indexes has been a constant concern. In [23] an indicator called virtual neutral to ground voltage ($V_{Ng}$) is proposed and compared against THD. In addition in [24] it is proposed a modified index which considers the phase electrical power $P_i = U_i \times I_i$ and a mapping function to detect the arc stability. These novel indexes try describing the load behavior by the correlation of electric phenomenon with the EAF Heat Process.

In EAF, as it has been mentioned and validated according to results in Table I CPC components change long the Heat Process and generated current $i_C$ is closely related to EAF load condition. A deeply analysis of the behavior of the CPC components cycle by cycle long the Heat Process could be used as an indicator of the process describing better the different conditions of the load in EAF. This way, the RMS value of the generated current, the scattering current or its harmonic content have the potential of being used as indexes in the EAF. The mentioned stability indexes ($V_{Ng}, P_i$) relate parameters that don't depend exclusively of the load as are voltage or power of the circuit. In difference CPC components relate directly with the load current which is a parameter whose behavior depends directly from the load conditions. Therefore the information provided by CPC could be useful for describing the Heat Process and monitor closer the changing condition of the load with the objective of taking better decision in EAF's optimization.

**Conclusion.**

To improve EAF electrical efficiency it is necessary a deeply understanding of the EAF energy transfer process considering voltage and current non-sinusoidal conditions. The CPC power theory can be used with the objective of getting more accurate information of the power phenomena and to propose new power indicators which could be used as stability indexes for EAF control systems. The implementation of Non-Sinusoidal power theories as Currents Physical Components (CPC) represents an opportunity to achieve a more complete analysis of the EAF power phenomena. The power indicators gotten with these currents make available information that could describe better and reflect closer to reality the EAF operation and power phenomenon long the Heat Process. In addition the current decomposition proposed by CPC offers the advantage in EAF of separate non-active current in independent current entities related each one with a physical phenomenon in the load considering as the non-sinusoidal as the HGL features in EAF. In this paper it was proposed and discussed the potential of CPC power theory in EAF power system characterization. In order to achieve more substantial results, it is the intention of the authors to expand the analysis proposed to the continuous analysis of the CPC indicators long the complete EAF's Heat Process. In order to have the statistical data of each one of the CPC currents and analyze its behavior cycle by cycle long the different stages of the Heat Process. In addition, because of the arc behavior, for a better physical understanding of the each one of the CPC component it is necessary explore concept of semi-periodic quantities and a deep analysis of the working power [18] produced by HGL.

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