UNIVERSITÀ DEL SALENTO

REDUCING EMISSIONS OF PCDD/F IN SINTERING PLANT: NUMERICAL AND EXPERIMENTAL ANALYSISBY THE EVOLUTIONARY DESIGN (ED) ALGORITHM IN modeFRONTIER®

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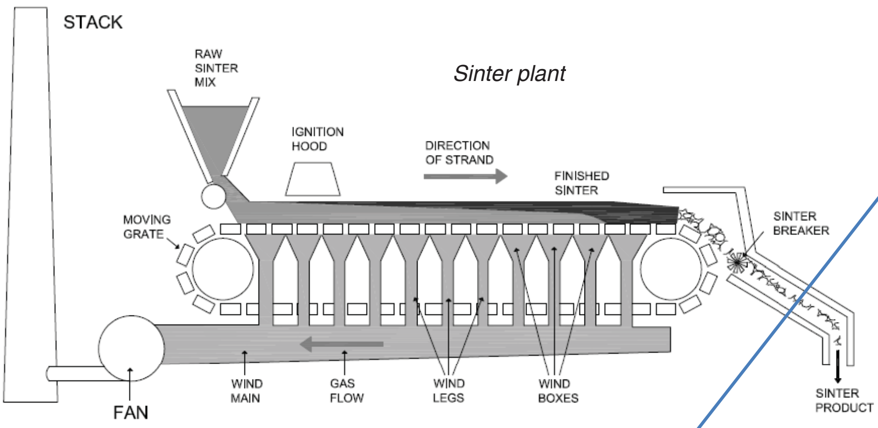
Experimental and numerical procedure

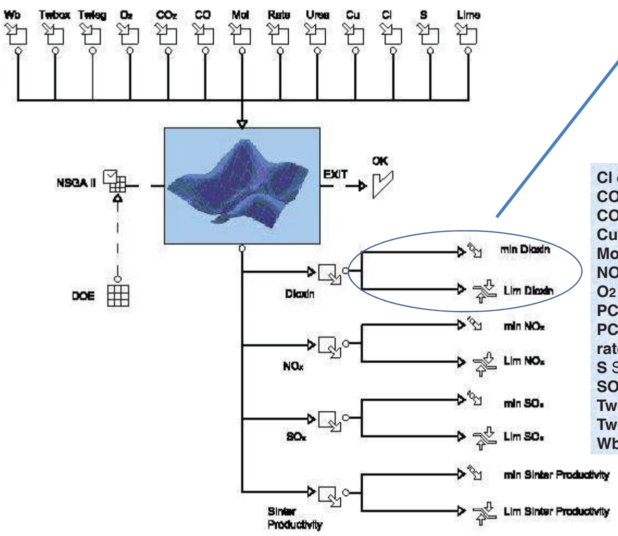
Sintering is a process for ironmaking operations; it represents one of the main sources of production emissions of polychlorinated dibenzo-p-dioxins, polychlorinated dibenzo-furans, NOx and SOx. In the present study, the operating conditions through which a reduction of dangerous emissions can be achieved are defined through numerical analysis. By employing a multiobjective optimisation tool, a deep analysis capable of representing the process behaviour leading to the optimal operating conditions was developed. Through such analysis, a broad range of processing parameters affecting the development of PCDD/Fs in the sintering process has been evaluated. The first aim was the possible reduction of dangerous emissions through numerical and experimental analyses allowing the definition of the optimal conditions for the minimisation of pollutants. Although the resultant optimal combination of input parameters able to reduce the dangerous emissions from the plant was determined, it was largely examined on the impact of the chosen input parameters on the sinter productivity. In such a way, it was possible to reduce the emissions close to the legal limits and with a high level of productivity and efficiency of the plant. Using the optimisation software modeFRONTIER (ESTECO), a virtual surface that can reproduce the actual process of sintering was created.



Analytical formulations by Evolutionary Design

DIOXIN= 5.353456 + ((((((((cos(ln(Cl)) / ((S * rate) / sqrt(Wb))) / (0.1 * rate)) + ((cos(Cl) + cos(ln(CO2))) + (ln(Cu) / (S * urea)))) / (S * rate)) / acos((cos(exp(Cl)) / ((0.1 * rate) / (S * rate))))) + (((((cos(ln(Cu)) / ((S * rate) / rate)) / ((S * rate) / (0.1 * rate))) + ((cos(Cl) + cos(ln(CO2))) + (ln(Cl) / (S * rate)))) / (0.1 * rate)) / (0.1 * rate))) / (0.1 * rate)) - sqrt(rate))

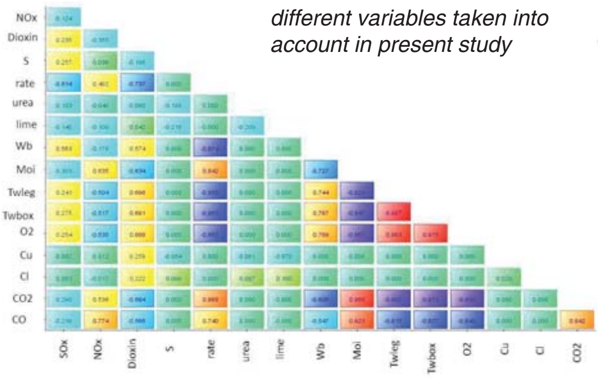
SOx= 46.735844817171824 + ((S + sin(sin(CO))) * ((sin((atan((sin((tanh(CO) + (Wb * Lime))) + (S + sin(CO)))) + atan(sin(((CO - Twbox) - atan((Wb * CO)))))))) * (CO * (sin((CO + sin(CO))) * (sin(CO) * ((((Wb* Wb) - urea) - Cl) + (Twleg + (Wb * Wb)))))))) + ((((sin(((Twbox +(Wb * Wb)) - 10)) + sin(((Twbox + (Wb * CO2)) - 10))) + (sin(((CO -Twleg) - (Wb * Lime))) + sin(((Twbox + (Wb * CO2)) - 10)))) * Wb) + ((tan(sin((((CO - Twbox) - (Wb * Lime)) - 10))) * ((sin(((CO + S) - Wb)) - Wb) - Wb)) + ((sin(((Twbox + (Wb * Wb)) - 10)) + sin(sin(((Wb * Wb) - Wb)))) + (Wb * Wb))))))



List of symbols

Cl chlorine rate
CO carbon monoxide
CO2 carbon dioxide rate
Cu copper rate
Moi moisture
NOx nitrides
O2 oxygen rate
PCDD polychrorinated dibenzo-p-dioxins
PCDF polychrorinated dibenzo-furans
rate air flowrate
S Sulphur rate
SOx sulphides
Twbox windbox temperature
Twleg windleg temperature
Wb windbox number

Correlation matrix between different variables taken into account in present study



The aim of this study was to analyse some crucial aspects of the iron ore sintering process. The study outlines the influence of different parameters affecting it in order to establish a set of operating conditions capable of reducing
the dangerous emissions. The way to tackle the problem consists of using numerical multiobjective optimisation software modeFRONTIER with which to define optimal operating conditions. The analysis led to the definition of a series of three best design practices that lead to lower emissions. Because these results are obtained in dangerous working conditions, they represented the starting point necessary to define a particular setting of the system that is easier to produce technologically, i.e. the new design. To fall below the legal limit regarding the maximum production of PCDD/F, a filtering device downstream of the sinter plant was finally applied. Large attention was put on the analysis of the reduction of dangerous emissions coupled with an acceptable level for productivity. All the input parameters, before the optimisation, were chosen in order to fall in a range guaranteeing an acceptable quality of the sintered
material in terms of dimension, spheridicity and voidance. The productivity of the plant, resulting from the chosen optimal input parameters, showed no significant
differences from the required ones. The results confirmed the applicability of the obtained optimal conditions for ordinary industrial production.

	SO_x/mg kg^{-1}	NO_x/mg kg^{-1}	PCDD/F/ng I-TEQ/N m^3	Productivity/t/m^2/24 h
New design	297	201	0·45	29·8
Design 1	291	177	0·43	29·0
Legal limit	400	400	0·4	