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Mathematical Modelling for the Measurements of PST Analysis

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Abstract

Plasma spraying is a major industrial development and users are looking for complex deposit structures. When plasma recycling, purification and extractive metallurgy are relatively young, the results obtained are promising and raise a lot of interest in industrial development. This is why better knowledge of the events involved is particularly needed in modeling the plasma mechanical modeling system when considering chemical reactions, mixing, uneven effects, and if possible using 3-D preparation. However, due to the complexity of the models and the many assumptions the results are meaningless compared to the measurements and great effort must be made to computerize all the existing equipment used to start a systematic mixing study. of plasma-cooled gas, reduced pressure spray equipment, particle injection and conduct, of heat transfer to electrodes or walls, of chemical kinetic.

Now, after a brief description of the Wermal plasmas industrial development in the field of extractive metallurgy and thermal spraying, the state of the art knowledge in various disciplines is being reviewed: plasma modeling, plasma transport structures and cold gas mixing. , plasma particle pressure measurement and heat transfer propagation values of plasma jet speed and particle temperature measurements in plasma jet plane: maximum temperature, speed, appearance of size, trajectory etc. related between ratings and statistics. In the present paper, there is a comparative analysis between the mathematical model and the actual measurements using the tests.

Keywords: Plasma spraying, Modelling, Plasma measurement.

1. Introduction

The formation of a protective material by plasma spraying of ceramic particles or molten metal was developed during the sixties. The maximum advantage of plasma compared to the maximum particle velocity obtained is up to 500 m / s and the maximum temperature achieved, i.e., over 10,0000 K which makes it possible to melt many resistant substances. The rapid stabilization of plasma coating concentrations up to K / s includes melting, quenching and solidification in a single operation and the

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resulting cooling levels of 0.25 to 0.5 grains, μm of metals and alloys. However, the quality of the coated material depends largely on one hand on the temperature and the transfer of pressure between the particles and the plasma (particles must melt when exposed) and regulate the chemical reaction of particles during flight and decomposition and decomposition. alternative way to control heat transfer to the substrate and deposit while spraying (Fauchais et al. 1985). For a long time, the development of the plasma-based clothing industry has intensified, and the physical and chemical understanding of this phenomenon lags far behind. Therefore, with the significant development of plasma-based deposits in the fields of aeronautics, nuclear engineering, mechanics, electrical engineering, etc., a better understanding of the events involved is needed to improve the quality of cover coatings and yield spraying; such deposit structures are required by the industry for being very complex. Improved event information is also required for the industrial development of plasma jets or arcs transferred to the following:

(i) Melting and refining by transfer arcs (100 ≤P ≤1000 kW) blown into a controlled atmosphere chamber between the cathode and the cooled water crucible; handy materials presented such as particles, pellets, sticks, hollow pieces etc.

(ii) Heating of steel buildings, explosive air installed in explosive fire walls.

(iii) Melting of wrists by energy levels.

(iv) Extractive metallurgy, still in its infancy, mainly uses arcs but has high potential experimental facilities in South Africa.

(v) Plasma reformer direct reduction is designed to reduce melting or production of directly reduced metal.

The purpose of this current paper is to make a brief review of the state of the art in the field of modeling and measuring plasma-injected jets or not, with solid particles and to try to underline what is lacking and what is still needed (Fauchais et al. 1985).

2. Plasma Modeling Processes

2.1 Plasma Flow

Despite the great research effort that has been devoted over the past three decades in the study of electrical arcs, mathematical modeling has improved slightly due to the difficulties encountered in the definition of electrode circuit analysis. The regions are organized with very high temperature gradients, low magnitude and unequal useful effects. It appears that the arc is capable of producing a

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wide variety of materials caused by small changes in electrode structures, geometry, and small impurities in their area. If at present the cathode phenomena is far from fully understood, especially the events of the release of cold cathodes i.e., cylindrical copper electrodes are now widely used in arc gas heaters, other phenomena have been concentrated on cold arodes containing argon as gas -such plasma. such as a negative anode drop, instead of the positively considered positive and strong unequal effects, an event that allows to understand heat transfer. Therefore, what happens when anode material evaporates (essential for dissolving, melting, extractive metallurgy, welding with transferred arcs) should be studied. A study by Tsantrizoo et al. with argon arc transferred to the molten copper anode provided a significant voltage change as soon as the anode evaporates. After some time spectroscopic measurements performed on Limoges with a TIG hit on a metal plate indicate that two plasma regions can be classified as a “pure” plasma region in L.T.E. and a "metallic vapor plasma area" next to the anodic molten bath. In a recent study, a strong discrepancy between the "argon temperature" values and the average arousal temperature values is observed. The results suggest that the amplitude of heat transfer at work is highly dependent on the efficiency of the basic processes that control the energy exchange between plasma "argon" and metallic "vapor" plasma within the arc plasma column. Electrode conditions must take into account the basic processes i.e., the inconsistency of the equilibrium effects and flow problems so that the model balance between gravity due to cold gas flow near the walls and magnetic field due to bending of plasma column when arc hits the nozzle anode of the plasma torch and this is currently too complex to be incorporated into flow models. The flow models developed can be with arc column or plasma jets coming out of the mouth. The main consideration for such models as plasma is in L.T.E., The jet is strong and has a cylindrical balance, and radiation transfer is not considered as a result of pressure without high plasma flow as this is used for spraying w. r. t. reduced pressure. Two types of methods are likely that the plasma jet should be laminar and the flow is defined by Navier Stokes statistics, continuous energy conservation of high Reynolds numbers, obtained by low temperature plasma ($T = 60000$ K), the dependent variables are divided into definition and variable components and resulting calculations for a limited period of time in order to generate total value estimates. Overcrowding usually has a heavy aver

2.2. Plasma Particle Momentum and Heat Transfer

Due to the importance of heat treatment of plasma torch powders and in the center great attention has been given to plasma particle pressure and heat transfer. These activities emphasize the need to consider the adjustment terms or the combined temperature characteristics of steep gradients in the boundary layer around the particles, the continuous effects of particles smaller than 10 m at

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atmospheric pressure, dispersion dispersion, charging effect, evaporation effect. At the given temperatures and the speed distribution of the plasma jet, the trajectory and temperature history of the individual particles, which are considered to be circular, are calculated. In order to do what is required the mathematical behavior of injected particles of size and speed distribution. With a given injection range and the company's gas flow rate the particles will be (due to size distribution) different injection speed and even at the appropriate injection speed, particles passing near the injection wall will have a normal egg speed. This is why trajectories and the temperature history of particles should calculate different sizes and speeds and the estimated effects depending on the initial distribution and the flow rates of the particles. In addition, when particle flow rate increases significantly the particles begin to cool the plasma jet and when smaller particles evaporate using a larger amount of energy and this should be included in the calculation system making it more difficult. Therefore, one should emphasize that all calculations do not take into account the cold gas injection which should require a 3-D count to take its effect on plasma flow.

3. Measurements and Comparison and Modeling

3.1 Measurement Requirements

Too much data is needed for the temperature and speed of plasma flow distribution and the unequal effects of mixing different species of happy or non-happy animals, speed, higher particle temperature to match the calculated distribution with those measured, to have reliable models and to obtain accurate data can be accurate. (extraction and Nusselt coefficients accounting for various phenomena) or plasma gas itself (chemical levels, diffusion coefficients etc.) (Synder et al. 2005).

3.2 Plasma Jet Ratings

3.2.1 Distribute the temperature

Easily accessible by emission spectroscopy, dramatic temperature (using atomic spectra), electron density (using Stark line magnification profiles), vibration temperature and rotation (using rotating spectra), but temperature this electron should be detected with the help of previous data. Indeed these measurements provide intermediate values (for a few decades ms) that close the arc fluctuations. Therefore, because of the radiation, Abel's conversion must be done. That is why all measurements are designed for axially symmetrical jets and great effort has been made to make these measurements automatically, by plasma transmissions, using rotating mirrors that quickly remove the metal line from the jet, devices allow for rapid atomic stiffness measurements. , using 2D optical multichannel analyzers (OMA) that allow rapid measurements of rotating spectra (up to 40 lines) or line profiles. It

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is worth noting that the rotating spectra will provide temperatures in the range of 3500 - 9000 K with atomic lines in the range of 8000 K - 13000 K, while the ionic lines are between 15000 and 21000 K and the accuracy is up to 10% (Tveekrem, 1963). Temperatures are found in the following various plasma:

Heating 3000 - 9000 K about, by spraying 3000- 12000 K, arcs transferred 7000 - 180000 K and one should be reminded that, according to the rapid variation of the output coefficients in volume, the range of about thirty years is attainable. in the provided set of measuring device corresponding to ∂T = 40000 K in bulk. In argon arc transferred to atmospheric pressure, when electron density is very high (ne = 1022 e / m3), the average temperatures are in a reasonable agreement (within 15%) with the calculated distribution. However with nitrogen d. c. plasma jet in which cold nitrogen is evenly distributed, estimates have shown that when increasing the cooling gas flow rate, the temperature of the iso-contours (measured from the corresponding rotating spectra, due to rapid translation fluctuations, to heavy particle temperatures) they are pinched. and expanded - the cooling of the ends causes the rapid scattering of electrons from the plasma center to the surrounding plane of the population of levels near the ionization threshold so it is no longer in the temperature range with one level of near-resonant levels, distribution events, most importantly in this where they have been neglected so far, certainly the first results of the cold gas injection emphasize the effects of inequality already under consideration. models, but where distribution results should be presented. It may also be important to develop concentrations in unbalanced plasma where these effects are likely to be enhanced. Abel's unequal fluctuations are now possible with the use of online computers to calculate the amount of data to be treated (Fauchais et al. 1985). Already designed for the simple case of hot plasma jets, the use of OMA strongly promises such measurements. If investment cost issues are not considered, the CARS method may be used in hot plasma to measure the maximum temperature of the types of temperatures, the increase in temperature (improved burning to 30000 K), most likely (up to 70000 K.). The advantage of CARS over the outgoing spectroscopy is that it is possible to get the best

3.3 Particle Measurements

3.3.1 Velocity

LDV is the main method used; allows for maximum surface adjustment (less than 1 mm3) and high temporary adjustment (up to 5 ns). Among the various detection equipment, only frequency trackers and calculators are able to associate speed with a given particle. Performing measurements on the plasma core itself requires on the one hand the use of a mono chromator with band pass round 1 A0 to

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eliminate, as far as possible, the light emitted by plasma and on the other hand or to increase power. laser level or increase the size of the measurement volume by doing it within an angle near the laser beam area to obtain a higher emission of diffused light.

3.3.2 Overheating

The latest method is that of a different pyrometer color, which was first developed with measurements of absolute variability when the accuracy was not good (the result depends on the coefficient of particle emission and its variable diameter as soon as the evaporation begins). Recently this method has been developed by measuring the rate of fluctuations emanating from two wavelengths (a two-color pyrometer) thus eliminating the frequency problem and reducing one of the unknown output coefficients (gray body assumptions) (Wiki, 2017). In fact, such measurements, made in volumes 160 = 160 µm, 1 = 15,000 µm, are mathematical estimates and actually provide a higher temperature distribution. Therefore, it is important to emphasize that, whatever the future strategy, it will not be possible to make measurements in the plasma jet core, the particle temperature and the flux can overcome plasma flow as their temperature is not high enough (approximately more than 2 2000 K with particles 20 µm).

3.3.3 Partic1e Methods and Focuses

The number of particles moving in different locations in a plasma jet can be calculated by calculating, in a given time, the pulses emanating from light dispersed by particles passing through the focus laser beam. Measuring volume less than 10-3 mm3 is achievable. Particle mean trajectory is characterized by the location of high particle concentration. It is worth noting that, even with the smallest size distribution (particles of Al2 03 18 ± 3 µm) injected at high speeds, the trajectory distribution is large: 20 mm below the injection, covering about 33% of the plasma surface. jet "piece".

3.3.4 Particle Size

Combined measurements of particle size and speed are achieved with extended Doppler laser anemometers: amplitude and depth of LDA signal variation depending on dispersed particle size, apparent particle material properties, wavelength of rental laser beams, angle angle. between the two incident bars and size and the reception area of the reception. These measurement systems are actually visual and measurement bases where size and speed measurement are obtained from the same signals and power measurement methods where optical probes for velocimetry and size vary.

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3.4 Relation to the calculation of Estimates

First one should note that measurements in particles and plasma flow are performed separately and secondly that, in order to obtain reliable information, particle measurements must be made at the same time and place. If the previous comparison between the calculated speed and the scale gives a reasonable agreement (within 15%) of the corresponding axis values, the difference between the calculated and measured temperatures is reduced by two colored pyrometers. However the latter estimates emphasize the importance of various impacts: evaporation, heat dissipation of pottery, Knudsen etc., but also the need to calculate the calculation of trajectories and velocities, higher temperatures and diameters to compare the distributed distribution with these calculations.

4. Conclusion

Plasma regeneration, purification and extractive metallurgy are in its infancy; The first results obtained are promising and raise a lot of interest in the industry. This is why better knowledge of the events involved is especially needed in modeling the preparation of different plasma machines using chemical reactions, mixing and uneven effects if possible using 3-D preparation. Now because of the complexity of the models and the many speculations the results are meaningless compared to the measurements and great effort must be made to compile all existing equipment to start a systematic study of mechanical mixing. cold plasma gas, reduced pressure spray equipment, particle and conductor injection, heat transfer on walls or electrodes, kinetic chemical.

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