SCIENTIFIC REVIEW OF ARC EFFICIENCY FACTORS

Background
In all calculations of the thermal effect of welding (like e.g. cooling rates), arc efficiency factors are used to "estimate" the loss of heat from the electric arc due convection, radiation, spatter, thermal diffusion etc. The efficiency factor $n$ for an electric arc can be defined as $n = q_o/(IU)$, where $q_o$ is the net power received by the weldment, $I$ is the welding current and $U$ is the arc voltage. Mostly $q_o$ is measured by calorimetric experiments. Often $n$ is also named process efficiency factor.

It was recently shown (with extensive experiments) that measured $n$ values can vary a lot, mainly due to how calorimetric experiments are carried out. For instance for the same type of welding (constant conditions) measured arc efficiency factors could vary between 80% down to 60%, depending on the measuring technique. Different authors have reported widely varying $n$ values. For instance, in Gas Metal Arc Welding (GMAW) some articles claim that $n$ is 85%, but others report values as low as 70%.

Faulty $n$ values will give rise to errors when calculating the thermal effect of welding. In 3D heat flow the error it is directly proportional to $\Delta n$, but in 2D heat flow it will be $2\Delta n$. The challenge is to know the accuracy of the arc efficiency and the influence of different parameters.

Target
Critically review quoted arc efficiency factors in the literature for Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW), with the aim of identifying factors influencing the value of $n$.
Propose a measuring technique for $n$, with a known and controllable measuring error, and to measure $n$ in a limited number of cases (GTAW, factorial tests).
**Main steps**
1. Literature survey
2. Critically evaluate found literature
3. Propose and build a new measuring technique
4. Conduct measurements
5. Report writing and presentation

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