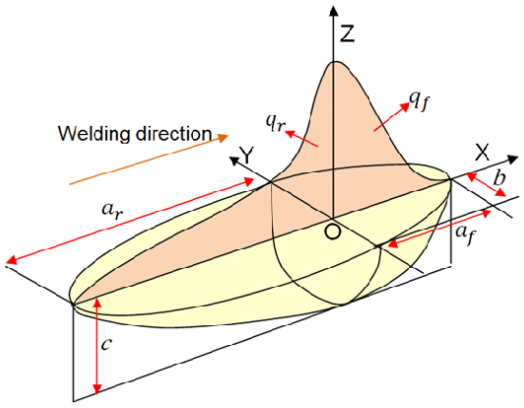
Goldak Double Ellipsoidal Heat Source

Goldak et al. (1984) derived a model to describe the volumetric heat flux acting on a plate due to an applied arc. For arc welds, accurate results are obtained with a power density distribution in which surfaces of constant power density are ellipsoids and on radial lines, the power density obeys a Gaussian distribution. In order to overcome the discrepancy between the predicted and measured temperature gradients in front and behind the arc, two ellipsoidal heat sources were combined, the front half of the source is the quadrant of one ellipsoidal source and the rear half of the heat source is the quadrant of another ellipsoidal heat source.



Governing equations:

The power densities of the double ellipsoidal ellipses, that comprise a front and a rear quadrant of the heat source can be stated as :

$$q_G(x,y,\xi)=\begin{cases}\dfrac{6\sqrt{3}Qr_f}{abc_f\pi\sqrt{\pi}}\exp\left[-3\left(\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}+\dfrac{\xi^2}{c_f^2}\right)\right]\forall\,(x,y,\xi\geq 0)\in\Omega\\ \dfrac{6\sqrt{3}Qr_r}{abc_r\pi\sqrt{\pi}}\exp\left[-3\left(\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}+\dfrac{\xi^2}{c_r^2}\right)\right]\forall\,(x,y,\xi<0)\in\Omega\end{cases}$$

Where rf and rr are the heat input proportions in the front and rear ellipsoid quadrants respectively: Q is the energy input rate from the arc given by the equation Q=ηVI, where η, V and I are the arc efficiency, arc input voltage, and arc input current respectively: a,b,cr and cf are the respective radii of the flux distributions defined such that the flux falls to 5% of its peak value at their spatial location.

Double-ellipsoidal volumetric source with Gaussian heat distribution is one of the most popular heat source models used for different fusion welding processes and AM simulations.

The major drawback of this heat source model is the selection of heat source parameters. Dimensions of the heat source are generally not known and there is no link between welding process parameters and dimensions of the heat source.

References:

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3. https://www.researchgate.net/figure/Double-ellipsoidal-volumetric-heat-source-Goldak-et-al-1984_fig1_258088501
4. https://www.youtube.com/watch?v=cbfqHdcFroY&t=4s