Abstract— The performances of the Stirling engine are affected by the convection coefficient and the “X” factor and not only by the variation of the gas quantity from the cylinder with the medium pressure variation. The convection factor indicates that a sensibility study concerning the characteristic parameters is mandatory.

Index Terms — Stirling, cycle, engine, convection.

I. INTRODUCTION

We will consider the most common case, which presents the regenerator as a “pressed bolters package”. In figure 1 are presented the geometrical characteristics for the bolter:

![Geometrical characteristics for regenerator’s bolters](image)

Figure 1. Geometrical characteristics for regenerator’s bolters

According to the figure 1, we can assimilate regenerator’s area with a square area equivalent to the regenerator’s:

\[ A_R = \frac{\pi D_R^2}{4} \]

where \( D_R \) – regenerator’s diameter;

\[ a = D_R \sqrt{\frac{\pi}{4}} = \frac{D_R \cdot \sqrt{\pi}}{2} \]

(2)

If \( L \) is regenerator’s length, then:

\[ N_s = \frac{L}{2d} \]

(3)

where:

- \( N_s \) – total bolter number;
- \( d \) – bolter’s wire diameter

From here results:

\[ (\text{wires in the equivalent square in X direction}) = \frac{a}{b + d} \] (4)

and:

\[ (\text{bolter’s wires in both directions}) = \frac{2a}{b + d} \] (5)

where \( b \) is the distance between two bolter’s wires

\[ (\text{bolter’s wires length}) = \frac{2a^2}{b + d} \] (6)

(regenerator’s wires length)

\[ \text{bolters number}) \cdot (\text{bolter’s wires length}) = L_f \] (7)

\[ L_f = \frac{2a^2}{b + d} \cdot \frac{L}{2d} = \frac{L \cdot a^2}{d(b + d)} \] (8)

With these relations we can determine the radius \( A_R \) and the weight \( m_R \). Knowing a form of second relation and using it in the 8th relation, results:

\[ L_f = \frac{L}{4d(b + d)} \]

(9)

The regenerator’s area will be:

\[ A_R = \frac{\pi \cdot D_R^2 \cdot L}{4(b + d)} \]

(11)

The regenerator’s weight will be:

\[ m_R = L_f \cdot A_R \cdot \rho_{metal} = \frac{\pi D_R^2 \cdot L}{4d(b + d)} \cdot \frac{\pi d^2}{4} \cdot \rho_{metal} \] (12)

where:

- \( A_R \) – wire’s area;
- \( \rho_{metal} \) – metal’s density

\[ m_R = \frac{\pi^2 \cdot D_R^2 \cdot d \cdot \rho_m \cdot L}{16(b + d)} \]

(13)

The ratio \( \frac{m_R}{A_R} \) will be:

\[ \frac{m_R}{A_R} = \frac{\pi^2 \cdot D_R^2 \cdot d \cdot \rho_m \cdot L}{16(b + d)} \]

(14)

The relation required to determine the “X” parameter, according with the regenerator’s properties will be:
The coefficient \( \text{Re}_{D} \) is determined for medium speed \( \dot{W} \) and \( D_{R} \), the diameter for regenerator’s empty shell.

\[
St = \frac{\alpha}{\rho \cdot \dot{W} \cdot c_{p}}
\]  

and

\[
\text{Pr} = \frac{v}{\alpha} = \frac{\rho \cdot c_{p} \cdot v}{\lambda} \frac{1}{\lambda}
\]

\( \alpha \) – convection coefficient; 
\( \lambda \) – conduction coefficient 
\( \rho \) – density 
\( c_{p} \) – constant pressure specific heat

The 26th relation may be developed as following:

\[
\alpha = \frac{0.79 \rho \cdot \dot{W} \cdot c_{p} \cdot \frac{\pi d}{4(b + d)} \cdot \text{Re}^{0.576}}{1 - \frac{\pi d}{4(b + d)} \cdot \text{Pr}^{2}}
\]

equivalent with:

\[
\alpha = \frac{0.79 \rho \cdot \dot{W}^{0.424} \cdot c_{p}^{1.5} \cdot \lambda^{2}}{1 - \frac{\pi d}{4(b + d)} \cdot \text{Pr}^{2} \cdot \text{Re}^{0.576}}
\]

REFERENCES


