Appendix E Relationships between Pore (Throat) Radius, Shape Factor, Specific Surface and Cross Sectional Area

From the point of network, the pore and throat in the pore network is presented as a series of capillary cylindrical tubes with a constant but arbitrary cross section and this section is described by a dimensionless shape factor G

$$G = \frac{VL}{A_s^2} \tag{E.1}$$

Where A_s is the surface area of the pore or throat unit; V is the unit volume; L is the length of the pore or throat. It is equivalent to

$$G = \frac{A}{P^2} \tag{E.2}$$

Where A is the cross-sectional area and P is perimeter (Mason and Morrow, 1991[130]).

In the pore network, the shapes of the cross section are usually presented by triangle, circle and square shown in Figure E.1.

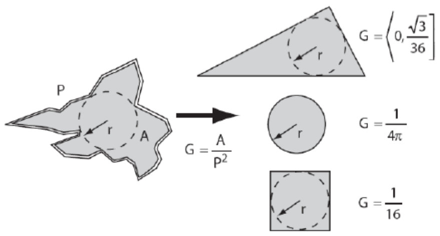

Figure E.1: The dimensionless shape factor for network pores and throats (Mason and Morrow, 1991[130]).

In the above figure, r is the radius of the pore and throat defined as the inscribed radius of the maximal ball (MB).

Another parameter used to describe the complexity of the pore system is specific area which is defined as

$$S = \frac{A_s}{V} \tag{E.3}$$

Where A_s is the surface area of the pore or throat unit; V is the unit volume; It can be simplified as the ratio between the total perimeter P and the total pore space area A of the cross section.

$$S = \frac{P}{A} \tag{E.4}$$

Generally, a small specific area presents a simple pore structure while a large number indicates an intricate pore system.

The relationship between shape factor, specific area, cross section area and pore unit radius can be derived according to the below formula.

For triangle in Figure E.2, the inscribed circle with radius r and the three angles for the triangle are 2α, 2β and 2γ respectively. The perimeter and area of the cross section can be expressed by the angles and radius.

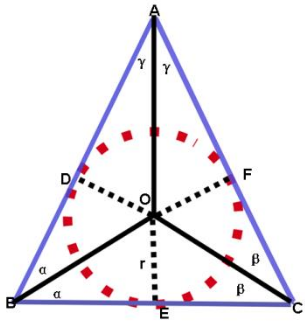

Figure E.2: The inscribed circle with radius r in an arbitrary triangle with three angles as 2α, 2β and 2γ.

The perimeter and area of the triangle can be expressed by the length of BD, FC and AD which are related to the inscribed circle radius r and the angles given in Equation E.5.

$$BD = \frac{OD}{\tan\alpha} = \frac{r}{\tan\alpha}$$
$$FC = \frac{OF}{\tan\beta} = \frac{r}{\tan\beta} \qquad (E.5)$$
$$AD = \frac{OD}{\tan\gamma} = \frac{r}{\tan\gamma}$$

And then the perimeter and area are expressed in Equation E.6 and E.7.

$$P = 2r\left(\frac{1}{\tan\alpha} + \frac{1}{\tan\beta} + \frac{1}{\tan\gamma}\right) \qquad (E.6)$$

$$A = r^2\left(\frac{1}{\tan\alpha} + \frac{1}{\tan\beta} + \frac{1}{\tan\gamma}\right) \qquad (E.7)$$

Setting $TAN = \left(\frac{1}{\tan\alpha} + \frac{1}{\tan\beta} + \frac{1}{\tan\gamma}\right)$, and then the relationship between shape factor and TAN is given by Equation E.8 and E.9.

$$G = \frac{1}{4TAN} \qquad (E.8)$$

$$TAN = \frac{1}{4G} \qquad (E.9)$$

The shape factor and the radius for each element (pore and throat) can be given in the pore network geometry, and then the area relating to the ratio of the cross section area between pore and throat (PTAR) and specific area reflecting the complexity of the pore system can be calculated by them in Equation E.10.

$$A = \frac{r^2}{4G} \qquad S = \frac{2}{r} \qquad (E.10)$$

For the rectangle shape, the shape factor, area of the cross section and specific area can be expressed by the pore or throat radius r in Equation E.11.

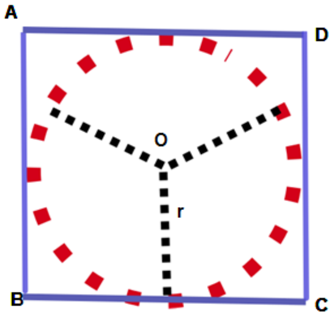

Figure E.3: The inscribed circle with radius r in a rectangular cross section.

$$G = \frac{1}{16} \qquad A = 4r^2 \qquad S = \frac{2}{r} \qquad (E.11)$$

For the circle shape, the shape factor, area of the cross section and specific area can be expressed by the pore or throat radius r in Equation E.12.

$$G = \frac{1}{4\pi} \qquad A = \pi r^2 \qquad S = \frac{2}{r} \qquad (E.12)$$