

The Relation Between Vertical and Horizontal Permeability

Arbuckle Formation – Wellington Field

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Based on routine core analysis data, a single relation does not exist between vertical (K_v) and horizontal (K_h) permeability in the Arbuckle formation. However, rock samples can be divided into five groups, and a specific relationship can be defined for each group. The Arbuckle is a layered formation, and vertical permeability of each layer is quite different from the surrounding layers. Therefore, it should be divided into layers based on K_v/K_h relationships.

Group 1

This group contains 15 samples; both vertical and horizontal permeability in these samples is less than 0.01 mD. Since actual vertical and horizontal permeability could not be measured in the lab and K_v/K_h could not be found, it is suggested to assume the following relation (Eq. 1; derived for Group 3) be applied to this group. Vertical fractures may not exist in this group.

$$\text{Eq. 1} \dots K_v = 0.1871K_h \\ R^2 = 0.5367$$

Group 2

Group 2 consists of 216 core samples. Vertical permeability of these samples is less than 0.01 md but horizontal permeability ranges from 0.02 mD to 210 mD. A vertical permeability of less than 0.01 mD (suggested 0.005 mD) could be assigned to layers of the reservoir with this type of rock. Vertical fractures may not exist in this group.

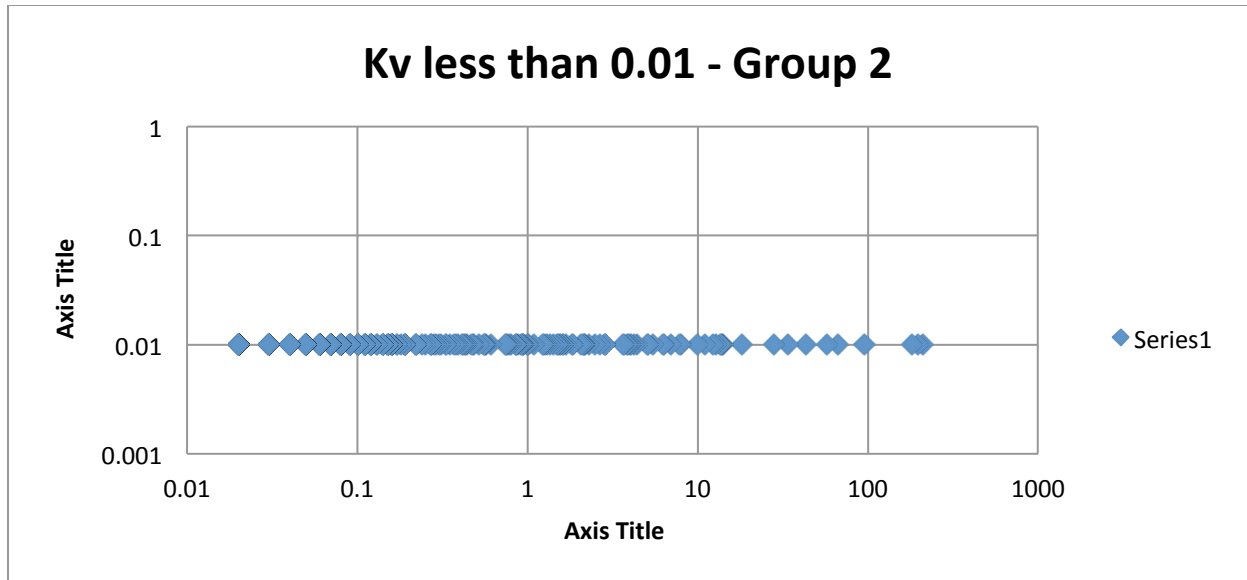


Figure 1 – Kv vs. Kh for Group 2 core samples

Group 3

This group has 97 core samples. As shown in fig. 2, vertical permeability of these samples is less than horizontal permeability and the following relation is proposed for determination of Kv. Vertical fractures may not exist in this group.

$$\text{Eq. 1 } K_v = 0.1871K_x$$

$$R^2 = 0.5367$$

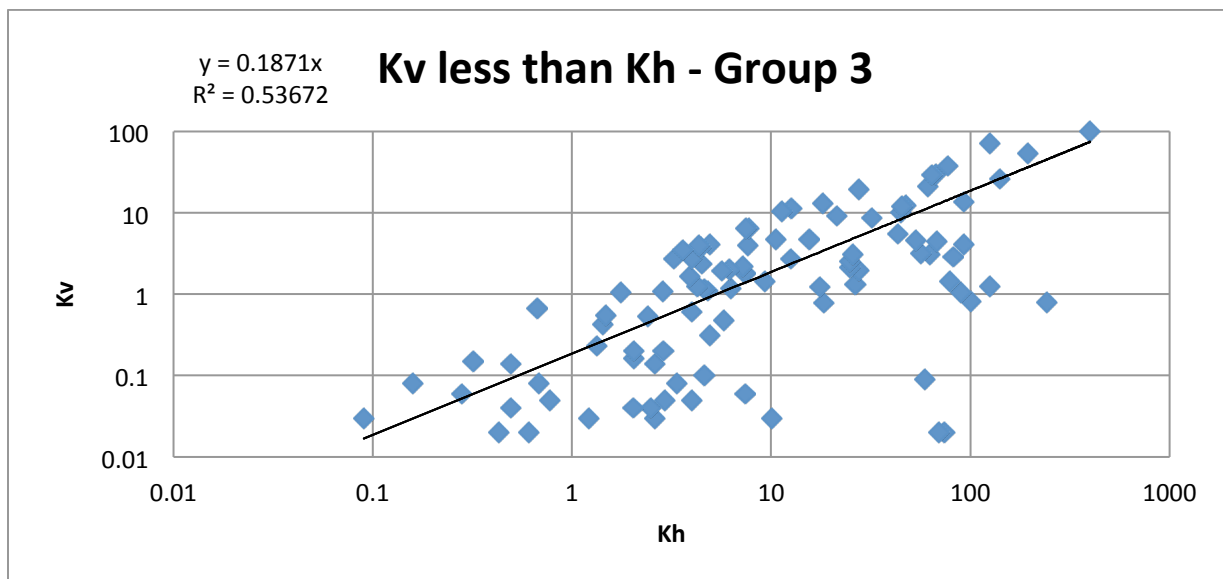


Figure 2 – Relation between Kv and Kh for Group 3 core samples

Group 4

There are 60 core samples in Group 4. Vertical permeability of these samples is more than horizontal permeability, as shown in fig. 3. Equation 2 describes the average relationship between Kv and Kh.

$$\text{Eq. 2 } K_v = 2.4484K_h \\ R^2 = 0.6916$$

This relation indicates that the rocks include vertical fractures that increase vertical permeability by several times.

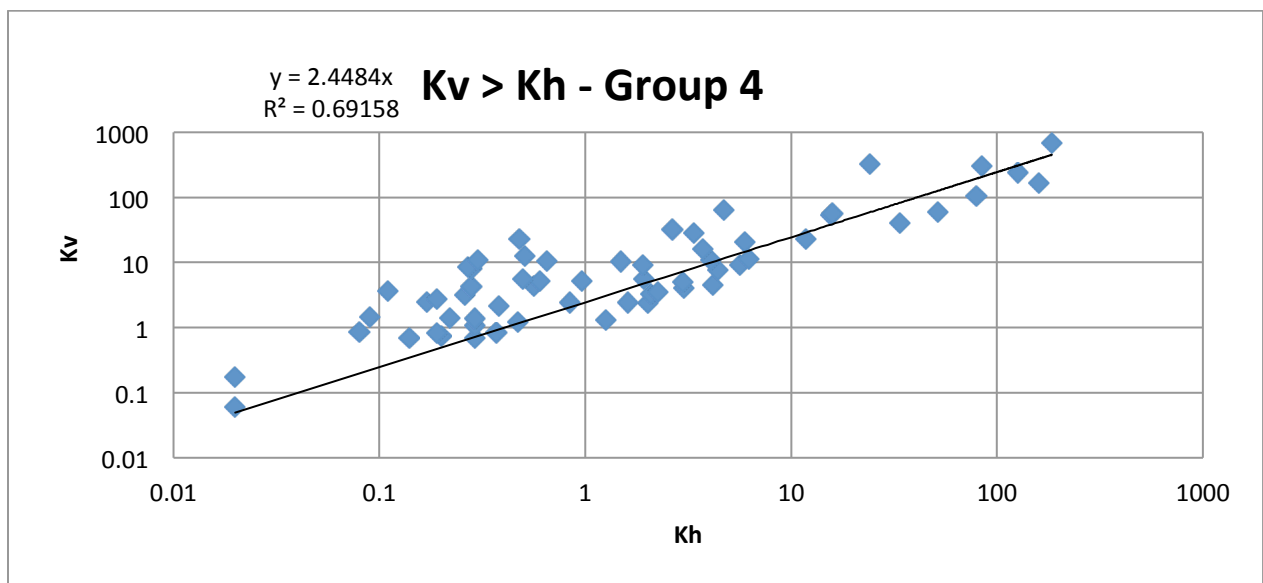


Figure 3 – Relation between Kv and Kh for Group 4 core samples

Group 5

This group has 18 core samples. Vertical permeability is much bigger than horizontal permeability, which shows that the rocks in this group are extensively fractured in a vertical direction. Figure 4 is a plot of Kv versus Kh, and the following relation is proposed for layers with this type of rock.

$$\text{Eq. 3 } K_v = 82.624K_h \\ R^2 = 0.9906$$

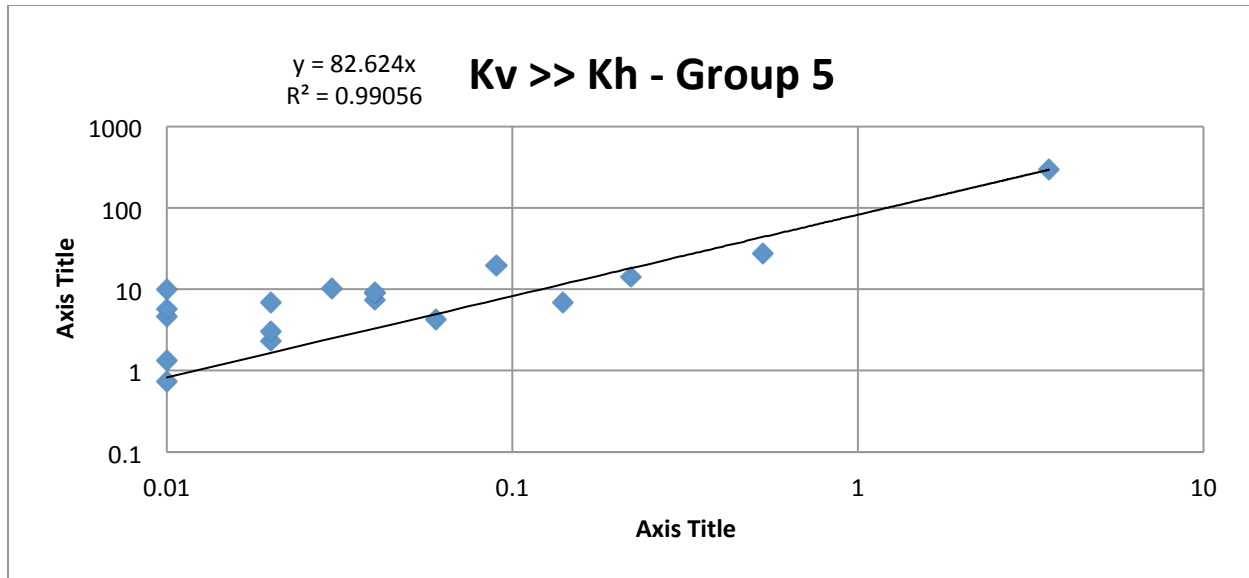


Figure 4 – Relation between Kv and Kh for Group 5 core samples