CHAPTER II

LITERATURE REVIEW

2.1. Oil Well Cement Stability

According to American Petroleum Institute (API) Specification 10A (2002), compressive strength for oil well cement is defined as the capability to restrain the forces that come either from the formation or the casing. The minimum allowable compressive strength for oil well cement is 500 psi (3.447 MPa). The compressive strength of the cement will be calculated by using the following equation:

$$f'_c = \frac{P}{A} \quad (2\text{-}1)$$

where:

f'_c = compressive strength, kgf/cm^2

P = maximum load, kgf

A = specimen cross section area, cm^2

According to API Specification 10A (2002), shear bond strength for oil well cement is defined as the capability to restrain the forces from the weight of the casing. The minimum allowable shear bond strength for oil well cement is 100 psi (0.689 Mpa).

The shear bond strength of the cement will be calculated by using the following equation (API Specification 10A, 2002):

$$SBS = \frac{P}{\pi D h} \quad (2\text{-}2)$$

where:

SBS = shear bond strength, kgf/cm^2

P = maximum load, kgf

D = specimen diameter, cm

h = Specimen height, cm

2.2. Expanding Additive

Expanding of cements means expansion of cement relative volume (an external part of cement visually becomes bigger) due to cement bulk expansion (Danjuschewskij, 1983). This occurrence is caused by:

a. Chemical contraction that formed another hydrated products on liquid phase condition, i.e. crystallizing of dissolved salt at high temperature.
b. The presence of expanding materials in cement slurry before hardened condition, i.e. CaO, MgO, $CaSO_4$, etc.
c. The presence of electrolyte around the cement bulk after the hardened condition.

The (b) part is merit condition that might bring to increase the shear bond strength (Rubiandini et al., 2005).

2.3. Other Researches to Compare

According to the research of Paramatatya (2014), the usage of calcium carbonate as the additive of oil well cement will increase the shear bond strength but decrease the compressive strength. The result of shear bond strength of the oil well cement with the calcium carbonate (CC) are 2.16 MPa (0% CC by weigh of cement (BWOC)), 3.95 MPa (0.011% CC BWOC), 4.48 MPa (0.045% CC BWOC), 10.56 MPa (1.174% CC BWOC), 13.07 MPa (2.285% CC BWOC). The result of the compressive strength of the oil well cement with the calcium carbonate are 24.69 MPa (0% CC BWOC), 24.00 MPa (0.011% CC BWOC), 23.33 MPa (0.045% CC BWOC), 22.85 MPa (1.174% CC BWOC) and 19.36 MPa (2.285% CC BWOC).

According to the research of Souza et al. (2012), ceramic waste and silica fume can be used as the additive to improve the compressive strength of the oil well cement. The result of compressive strength of the oil well cement with the ceramic waste (CW) and silica fume (SF) are 28.61 MPa (0% CW, 0%SF BOWC), 22.61 MPa (20% CW, 30%SF BOWC), 25.92 MPa (25% CW, 25%SF BOWC), 26.80 MPa (30% CW, 20%SF BOWC), 31.64 MPa (0% CW, 40%SF BOWC).