A definition sketch for the tides and current is shown in Fig. 4.

Solution

Selecting

$$\eta_o = a_o \sin(\theta - \tau) \qquad (2\text{-}14)$$

Eq. (2-12) can be solved for η_B as a function of a_o, θ and K. Note that τ represents the time lag as indicated in Fig. 4. Because of the non-linearity of Eq. (2-12), η_B is not a sine curve, but has higher harmonics.

To an engineer, three aspects regarding the hydraulics of inlet-bay are of greatest significance.

1. Lag of Slack Water ε, After HW and LW in the Ocean

Slack water is the time of zero current just prior to current reversal. According to the simple case depicted in Fig. 4, this occurs when the ocean and bay tide curves intersect, i.e., There is no head difference necessary for flow. The time lags (in radians) of slack after HW and after LW are observed to be the same, in this idealized case.

Keulegan's solution for ε in degrees as a function of the repletion coefficient K is presented in Fig. 5. Note that the time of slack water is also the time of maximum bay elevation according to this model, as seen in Fig. 4. As the lag ε increases, the bay tide becomes smaller until ε approaches 90° when there is no tidal fluctuation in the bay. This limiting situation occurs when $K \to 0$, which can occur when the bay is so large that $A/A_B \to 0$, or when the friction term under the square root sign in the denomenator (Eq. 2-13) tends to be very large.

The other limiting situation is when $K \to \infty$, when $\varepsilon \to 0°$. This is the case of a very wide inlet (A/A_B large) or negligible friction. Fig. 4 shows that in this case the bay tide approaches the ocean tide.