Background:

Preheating of the feed in distillation columns is done usually for the following reasons

1. To save energy: Feed pre-heater normally uses the residue/bottoms from the tower, with little value, this saves more valuable re-boiler steam.
2. Stops flooding in bottom section trays: If the tower is limited by flooding or entrainment in the bottom stripping trays, then more the feed preheated, reduces the re-boiler duty which will further improve fractionation.

Description of Flow-Sheet:

The feed is sent to a heat exchanger where it is heated by the recycled bottoms from the distillation column. Preheated feed is now sent into the distillation column at 5^{th} tray of a column of 10 trays. Reflux ratio maintained is 2 to give best separation.

Results:

The mole fraction of methanol in top stream is 0.899 or 0.93 mass fraction. The bottom stream of distillation column is purely water with mole fraction 0.999. Both the streams have 0 Vapor phase mole fraction. The cold feed is entered in heat exchanger at 299.85 K and leaves the heat exchanger at 324.795 K. The bottom stream is used for preheating of feed. The bottom stream leaves heat exchanger at 327.84 K.

Reference:

Mass Transfer Operations by Robert E. Treybal (3^{rd} Edition), Ch- 9 Distillation.