Ebulliometric Determination of %Alcohol in Wine

Ebulliometry involves the measurement of the decrease in the boiling point (BP) caused by the presence of alcohol in a wine sample. Because the boiling point of a solution also varies with atmospheric pressure, the effects of ethanol are evaluated relative to the boiling point of a control sample of distilled water (determined under identical conditions). The relationship between Δt (**BP**$_{water}$ – **BP**$_{wine}$) and the %alcohol in the original wine sample is depicted in Figure E-1.

Procedure
Step 1: Determination of Boiling Point of Wine Sample (1:1 dilution)
    a.   Add 100ml of distilled water to boiling flask
    b.   Add 100ml of wine sample to boiling flask (1:1 dilution)
    c.   Insert temperature probe into central port of boiling flask (see Fig E-2).
           Tip of temperature probe should be submerged approximately 1 inch.
    d.   Attach condenser to boiling flask.
           Connect hoses and turn-on cooling water (slow but steady flow rate).
    e.   Turn-on heating mantle to highest setting.
    f.   Monitor temperature increases.
           Begin recording temperature at 15-sec intervals once it exceeds 90°C.
    g.   Boiling point is reached when temperature remains unchanged for 3 consecutive samples.
    h.   Record boiling point for diluted wine sample (**BP**$_{wine}$).

Step 2: Determination of Boiling Point for Distilled Water (Atmospheric Control)
    a.   Allow apparatus to cool.
    b.   Thoroughly rinse out contents of the boiling flask.
    c.   Add 200ml of distilled water to the boiling flask.
    d.   Determine boiling point using same procedure described in Step 1 above. Record **BP**$_{water}$.
           Note: Cooling condenser not needed for Step 2 as there is no risk of alcohol evaporation.

Step 3. Compute %Alcohol Estimate
    a.   Determine difference in boiling points (Δt) as follows:
           Δt = **BP**$_{water}$ – **BP**$_{wine}$
    b.   Use Equation E-1 and Δt to determine %Alcohol in the original wine sample.
           Note: Figure/Equation E-1 has been adjusted to account for the 1:1 dilution of the wine.

Equation E-1.
$$\%Alcohol = 0.435 + 1.6687(\Delta t) + 0.1234(\Delta t^2)$$

Note:
Residual sugar levels greater than 4% in the original wine sample may interfere with estimates of %alcohol. The effects of high residual sugar levels can be corrected by applying the following formula:

%alcohol = est. %alcohol – (%residual sugar * 0.025)

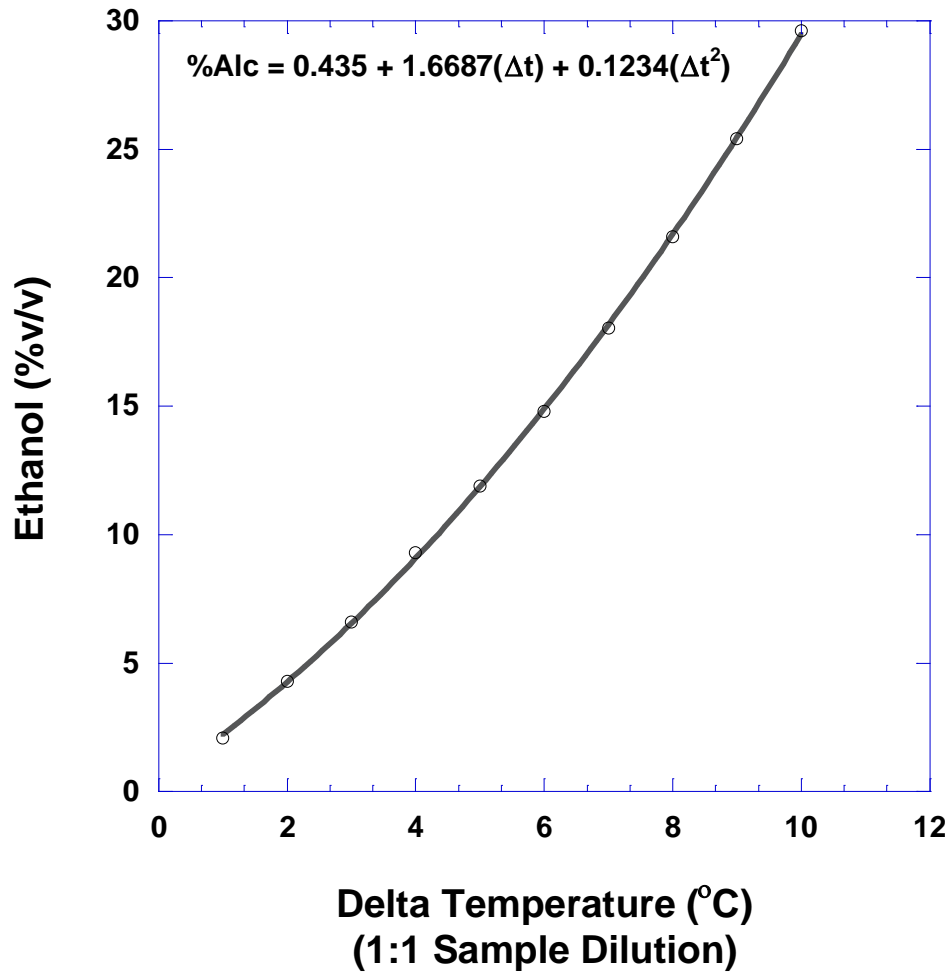%Alc = 0.435 + 1.6687(Δt) + 0.1234(Δt^2)

Figure E-1.
Estimated percent alcohol using a 1:1 diluted sample of wine as a function of the difference in the boiling points of the sample versus a distilled water control.

Equation E-1.

%Ethanol = 0.435 + 1.6687(Δt) + 0.1234(Δt^2)

Ebulliometry Equipment List

100 ml pipette or graduated cylinder for collecting proper volume of wine sample
Electromantle 500-ml heating mantle
500-ml 2-neck boiling flask (24/40)
Leibig condenser (24/40)
IMC 2400 precision digital thermometer
IMC 8011-2009 temperature probe
Drilled #6 rubber stopper (for temperature probe)
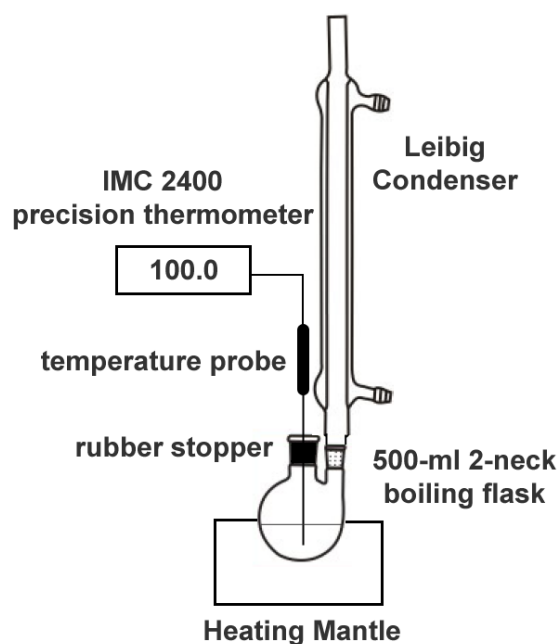Laboratory stand and miscellaneous clamps
Hoses for condenser cooling water

Figure E-2. Ebulliometry Apparatus