



# Chemistry in Context

The Western Australian Wine Industry

## Alcohol Content

The standard approach to determining alcoholic content in the wine industry is either by distillation followed by hydrometry or by ebulliometry. The apparatus required is not common in schools. In the laboratory the alcoholic strength of wines can be determined by density measurement following distillation or by redox titration. The redox titration method is unreliable.

### Experiment I: Distillation and Density Measurement.

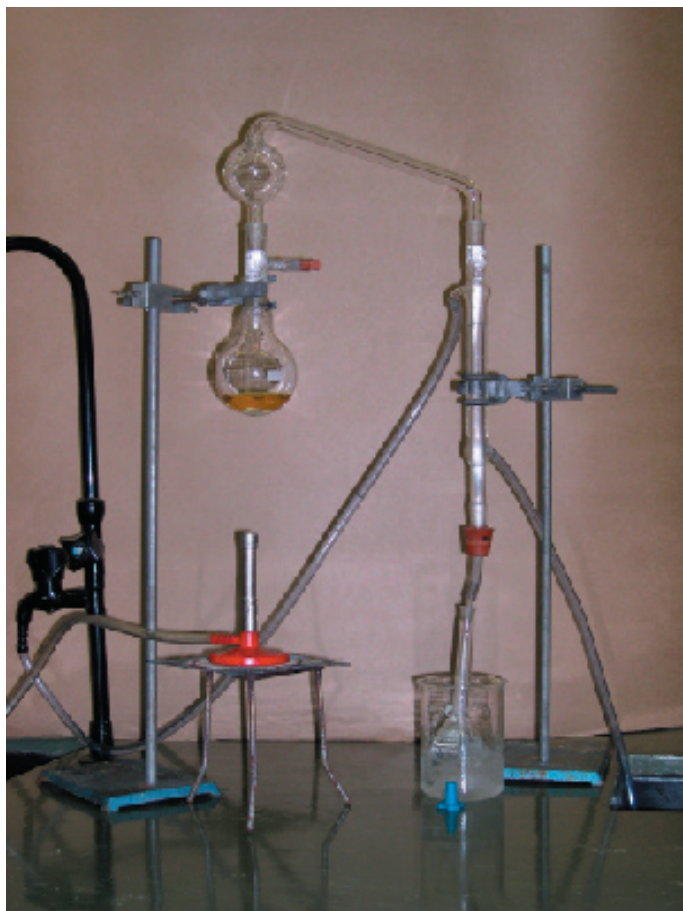
#### Procedure

1. Place about 130 mL of wine in a 250 mL conical flask and stopper the flask.. Stand the flask in a water bath at 15°C for about 15 minutes.
2. Pipette 100.0 mL of wine into a dry round bottom distillation flask.
3. Add drops of 1.0 M NaOH to the wine sample to make it just alkaline (use pH paper). Place some boiling chips in the flask.
4. Dry and accurately weigh a 100.0 mL volumetric flask, including the stopper. Record the weight of the flask.
5. Connect the distillation apparatus as shown in the diagram (picture). Ensure that all connections are secure. Add about 5 mL of distilled water to the volumetric flask and stand the flask in an ice bath as shown.
6. Ensure that water is flowing through the condenser. Heat the distillation flask and collect the distillate until the temperature reaches 100° or until the about half the contents of the distillation flask have been distilled over.
7. Stand the volumetric flask in a water bath at 15°C for about 10 minutes.
8. Top up the volumetric flask to the calibration mark with 15°C distilled water. Thoroughly dry the outside of the volumetric flask then accurately weigh the flask.
9. Using the density-composition data in the appendix determine the alcohol concentration of the wine, (% v/v).

## Apparatus

Assemble the apparatus as per the photograph. Some of the apparatus is of the quickfit type and it is likely that some schools may not have some or all of the pieces shown. Alternatives can be fashioned out of non-quickfit using standard glassware and appropriate rubber fittings. It is important to maintain secure, leak proof joints.

- Distillation flask 250 mL
- Boiling chips
- Quickfit distillation delivery tube (glass and/or rubber tubing substitute)
- Condenser
- Volumetric flask 100 mL
- Large beaker or container for the ice bath
- Electronic balance



## Reagents

- M NaOH (approximate concentration)
- pH paper
- 100 mL wine or juice sample

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## Experiment 2 Using an Alcohol Hydrometer

A more common practice in the wine industry is the determination of alcoholic strength using an alcohol hydrometer. If a suitable hydrometer is available then the distillation is performed as in experiment 1 but with the following modifications.

1. Fill a 250.0 mL volumetric flask with wine/juice to just above the graduation line.
2. Stand the flask in a water bath to adjust the temperature of the sample to 20°C. Adjust the volume to the graduation line by extracting wine with a pipette.
3. Transfer the entire contents of the volumetric flask into a 500 mL distillation flask. Rinse the volumetric flask with distilled water two or three times and add the rinsings to the distillation flask.
4. Distil as in experiment 1 and collect the distillate in a 250.0 mL volumetric flask.
5. Stand the distillate flask in a water bath and bring the temperature to 20°C. Adjust the volume to the calibration mark using 20°C distilled water.
6. Use a small sample of the distillate to rinse a clean 250 mL measuring cylinder. Transfer the remaining contents of the flask to the measuring cylinder.
7. Gently lower a suitable hydrometer into the liquid. Spin the hydrometer gently to ensure that it floats freely.
8. Read the hydrometer at the point just below the meniscus.
9. If the temperature of the liquid varies from 20°C then a correction factor needs to be included. For most common wines, with an expected alcohol content in the range 8 – 15 % alcohol v/v, with temperature in the range  $20^{\circ} \pm 2^{\circ}\text{C}$  the correction factor is
  - i. Add 0.20 for each °C below 20
  - ii. Subtract 0.20 for each °C above 20

### Apparatus

Assemble the apparatus as per the photograph in experiment 1. Ensure that all joints are secure.

- Distillation flask 500 mL
- Boiling chips
- Quickfit distillation delivery tube (glass and/or rubber tubing substitute)
- Condenser
- Volumetric flasks 250 mL
- Large beaker or container for the ice bath
- Alcohol hydrometer

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## Experiment 3 A Redox Titration Method

A procedure for performing this analysis is given in the Teacher's Resource Book *Chemistry Two* (Heinemann). In the second edition of this book it is experiment 16 (page 25). The procedure is based on a back titration technique.

## Appendix

Specific Gravity	% Alcohol by Volume	Specific Gravity	% Alcohol by Volume	Specific Gravity	% Alcohol by Volume	Specific Gravity	% Alcohol by Volume
1.00000	0.00	0.99417	4.00	0.98897	8.00	0.98435	12.00
0.99984	0.10	0.99403	4.10	0.98885	8.10	0.98424	12.10
0.99968	0.20	0.99390	4.20	0.98873	8.20	0.98413	12.20
0.99953	0.30	0.99376	4.30	0.98861	8.30	0.98402	12.30
0.99937	0.40	0.99363	4.40	0.98849	8.40	0.98391	12.40
0.99923	0.50	0.99349	4.50	0.98837	8.50	0.98381	12.50
0.99907	0.60	0.99335	4.60	0.98825	8.60	0.98370	12.60
0.99892	0.70	0.99322	4.70	0.98813	8.70	0.98359	12.70
0.00877	0.80	0.99308	4.80	0.98801	8.80	0.98348	12.80
0.99861	0.90	0.99295	4.90	0.98789	8.90	0.98337	12.90
0.99849	1.00	0.99281	5.00	0.98777	9.00	0.98326	13.00
0.99834	1.10	0.99268	5.10	0.98765	9.10	0.98315	13.10
0.99819	1.20	0.99255	5.20	0.98754	9.20	0.98305	13.20
0.99805	1.30	0.99241	5.30	0.98742	9.30	0.98294	13.30
0.99790	1.40	0.99228	5.40	0.98730	9.40	0.98283	13.40
0.99775	1.50	0.99215	5.50	0.98719	9.50	0.98273	13.50
0.99760	1.60	0.99202	5.60	0.98707	9.60	0.98262	13.60
0.99745	1.70	0.99189	5.70	0.98695	9.70	0.98251	13.70
0.99731	1.80	0.99175	5.80	0.98683	9.80	0.98240	13.80
0.99716	1.90	0.99162	5.90	0.98672	9.90	0.98230	13.90
0.99701	2.00	0.99149	6.00	0.98660	10.00	0.98219	14.00
0.99687	2.10	0.99136	6.10	0.98649	10.10	0.98209	14.10
0.99672	2.20	0.99123	6.20	0.98637	10.20	0.98198	14.20
0.99658	2.30	0.99111	6.30	0.98626	10.30	0.98188	14.30
0.99643	2.40	0.99098	6.40	0.98614	10.40	0.98177	14.40
0.99629	2.50	0.99085	6.50	0.98603	10.50	0.98167	14.50
0.99615	2.60	0.99072	6.60	0.98592	10.60	0.98156	14.60
0.99600	2.70	0.99059	6.70	0.98580	10.70	0.98146	14.70
0.99586	2.80	0.99047	6.80	0.98569	10.80	0.98135	14.80
0.99571	2.90	0.99034	6.90	0.98557	10.90	0.98125	14.90
0.00557	3.00	0.99021	7.00	0.98546	11.00	0.98114	15.00
0.99543	3.10	0.99009	7.10	0.98535	11.10		
0.99529	3.20	0.98996	7.20	0.98524	11.20		
0.99515	3.30	0.98984	7.30	0.98513	11.30		
0.99501	3.40	0.98971	7.40	0.98502	11.40		
0.99487	3.50	0.98959	7.50	0.98491	1.50		
0.99473	3.60	0.98947	7.60	0.98479	11.60		
0.99459	3.70	0.98934	7.70	0.98468	11.70		
0.99445	3.80	0.98922	7.80	0.98457	11.80		
0.99431	3.90	0.98909	7.90	0.98446	11.90		