

### Mash Viscosity Characterization in Brewing Method

#### Scope

- Characterize grain quality (adjunct level) for mashing during brewing.

#### Rapid Visco Analyser

The Rapid Visco Analyser (RVA) is a cooking stirring viscometer with ramped temperature and variable shear profiles optimized for testing viscous properties. The instrument includes international standard methods as well as full flexibility for customer tailor-made profiles. Combining speed, precision, flexibility and automation, the RVA is a unique tool for product development, quality and process control and quality assurance.



#### Description

This procedure is based on the method of Goode *et al.* (2005) using malted and unmalted barley, to study the effect of endogenous enzyme and added adjunct levels, respectively, on mash viscosity. This profile can be used to check the suitability of a batch of grain for mashing, or for checking the appropriate level of added adjunct in the mashing system.

The RVA is used as a laboratory-scale rheological tool for the characterization of mash viscosity, allowing the brewer to monitor the processes that are taking place during mashing. In a typical brewing process, the four main enzymatic reactions occurring during mashing are the hydrolysis of proteins into peptides and free amino acids (by proteolytic enzymes), the degradation of  $\beta$ -glucan chains (by glucanolytic enzymes), the hydrolysis of pentosans (arabinan, xylans) (by pentosanolytic enzymes) and the breakdown of gelatinized starch into both fermentable (glucose, maltose and maltotriose) and unfermentable carbohydrates (DP • 4) (by amylolytic enzymes).

This profile simulates an industrial time/temperature curve which would typically be used in brew-house processing. During the initial temperature rest (50°C), the viscosity would initially increase to a peak as the grain components hydrate and swell, followed by a breakdown in viscosity due to the action of endogenous proteolytic, glucanolytic, and xylanolytic enzymes. The second rest (62°C) would see a sharp increase in viscosity due to starch gelatinization. The viscosity reaches a peak (gelatinization peak) before breaking down due to amylase (mainly  $\beta$ -amylase) activity. The height and time of this peak reflects the concentration of the starch and the level of amylase. The rate of viscosity breakdown after the peak gives an indication of the digestibility of the gelatinized starch. The third rest temperature (72°C) deactivates  $\beta$ -amylase and favors  $\alpha$ -amylase. The viscosity continues to decrease as the gelatinized starch is further hydrolyzed into low molecular weight dextrans and glucose. The final rest temperature (78°C) ensures that all enzymes are inactivated.

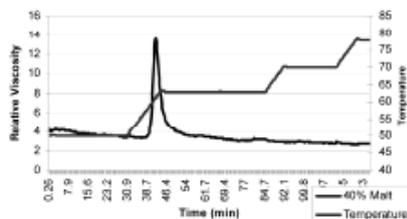


Fig. 1. Graphical representation of a typical barley sample tested using the mashing profile. Source: Goode et al. (2005).

## Method

The ground grain is tested using a profile that simulates the mashing step in a brew-house.

## Sample Preparation

Test  $7.840 \pm 0.001$  g ground grain (14% moisture basis) and  $20.160 \pm 0.001$  g distilled water using the following profile. Keep the liquor to grist ratio constant at 2.57:1.

## Profile

Time	Type	Value
00:00:00	Temp	50°C
00:00:00	Speed	960 rpm
00:00:10	Speed	160 rpm
00:30:00	Temp	50°C
00:42:00	Temp	62°C
01:22:00	Temp	62°C
01:32:00	Temp	72°C
01:52:00	Temp	72°C
01:58:00	Temp	78°C
02:03:00	End	
Idle Temperature: $50 \pm 1^\circ\text{C}$ Time Between Readings: 0.5 s		

## Measure

- Peak viscosity at 50°C rest (PV50)
- Viscosity at 30 minutes (Visc@30min)
- Rate of viscosity breakdown at 50°C rest (BR50)
- Gelatinization peak (GP)
- Gelatinization peak time (GPTime)
- Gelatinization temperature (GT) prior to GP
- Gelatinization time (GTime)
- Area under gelatinization peak (A)
- Rate of viscosity breakdown at 62°C (BR62)
- Rate of viscosity breakdown at 72°C (BR72)
- Final viscosity (FV)

Low levels of endogenous enzymes generally result in higher PV50, due to the high water-binding capacity of macromolecules such as  $\beta$ -glucans, arabinoxylans and proteins. Increasing the level of malt would see a decrease in PV50, PV62, Visc@30min, BR50, BR62, BR72, GPTime and A; and increase in GT and GTime.

## Reference

Goode, D.L., Wiltshcko, E.A., Ulmer, H.M. and Arendt, E.K. 2005. Application of the Rapid Visco Analyser as a rheological tool for the characterization of mash viscosity as affected by the level of barley adjunct. Journal of the Institute of Brewing 111(2):165-175.