

# RAT

## Purpose

The **RAT** (Rapid Alkali Test) measures the amounts of sodium and potassium ions that may contribute to alkali-silica reaction (ASR) if reactive aggregates are present. ASR leads to expansive products that can cause extensive cracking in concrete structures. The alkalis (potassium and sodium ions) in the cement paste react with reactive (amorphous) silica particles in fine or coarse aggregate and cause expansion and cracking, provided sufficient moisture is present.

To reduce the risk of ASR in new concrete structures, the quantity of sodium and potassium ions in the cement paste of fresh concrete should be reduced so as not to exceed the critical limit defined in the project specifications.

The **RAT** measures the amount of sodium and potassium ions in the fresh concrete or in its constituents. The test may also be used for testing powder samples of hardened concrete.

## Principle

A sample of the fresh concrete, or its constituents, is taken and mixed with a specific amount of acid extraction liquid. A calibrated set of electrodes, one for measuring the sodium ions and one for measuring the potassium ions, is submerged into the solution and the corresponding electrode readings (in mV) are taken.

The mV-readings are transformed directly into amount of  $\text{Na}_2\text{O}$  and  $0.658 \times \text{K}_2\text{O}$  in  $\text{kg}/\text{m}^3$  by means of established calibration curves. The two values are added together to give the equivalent amount of total  $\text{Na}_2\text{O}$ .

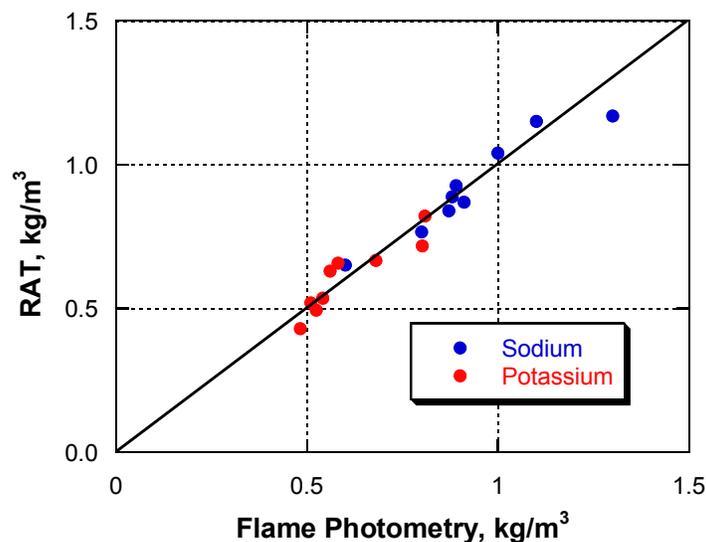
One test takes about 10 minutes to perform after the electrodes have been calibrated.

Similarly, for hardened concrete, a powder sample may be analyzed. If aggregates containing reactive material need to be excluded, a core is taken, the core is fractured, and the aggregate particles are removed. The remaining material is then pulverized and analyzed.

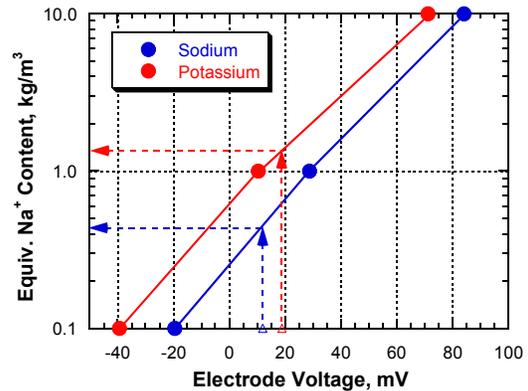
## Correlation with Other Methods and Variability

The graph shows the correlation between alkali contents determined by flame photometry and **RAT**, for tests performed on the same solutions prepared from different concrete mixtures. The test solutions were prepared by acid extraction of the alkalis.

The correlation coefficient for these results is 0.97 and the alkali contents determined by **RAT** are within  $\pm 5\%$  of the values determined by flame photometry.



## Testing Example



Calibration of the electrodes is performed using three calibration liquids. Typical calibration curves as indicated in the above graph. The concrete sample is dissolved in the extraction liquid, and the electrodes are submerged into the solution. In this example, the mV-reading for the Na<sup>+</sup> electrode is 12.0 mV and for the K<sup>+</sup> electrode it is 18.9 mV. The corresponding amounts of equivalent Na<sub>2</sub>O are 0.46 kg/m<sup>3</sup> and 1.40 kg/m<sup>3</sup>, respectively. Adding these values gives an equivalent Na<sub>2</sub>O content of 1.86 kg/m<sup>3</sup>.

## The RAT-1000 Kit and Ordering Numbers



Item	Order #
K <sup>+</sup> electrode	RAT-700
Spare cover for K <sup>+</sup> electrode	RAT-701
Na <sup>+</sup> electrode	RAT-800
Spare cover for Na <sup>+</sup> electrode	RAT-801
Reference electrode	RAT-900
Holster for electrodes	RAT-910
Electrometer w. spare battery	RAT-950
Adaptor switch box	RAT-960
Wetting agent for K <sup>+</sup> electrode	RAT-970
Wetting agent for Na <sup>+</sup> electrode	RAT-980
Wetting agent for ref. electrode	RAT-990
Set of filling syringes, three	RAT-1005
Spray bottle with distilled water	RAT-1010
Calibration liquid # 1	RAT-1020
Calibration liquid # 2	RAT-1030
Calibration liquid # 3	RAT-1040
Cleaning tissues	RAT-1050
Calibration sheets, 30 pcs	RAT-1060
Data sheets, 30 pcs	RAT-1070
Pencils (black and red) and ruler	RAT-1080
Spatula, 5 pcs	RAT-1090
Safety goggles	RAT-1100
Rubber gloves	RAT-1110
Mixing container	RAT-1120
Sampling cup for fresh concrete	RAT-1130
Plastic lid with holes for electrodes	RAT-1140
Temperature probe	RAT-1150
Vials for hardened concrete	RAT-1160
Vials for fresh concrete	RAT-1170
Manual	RAT-1180