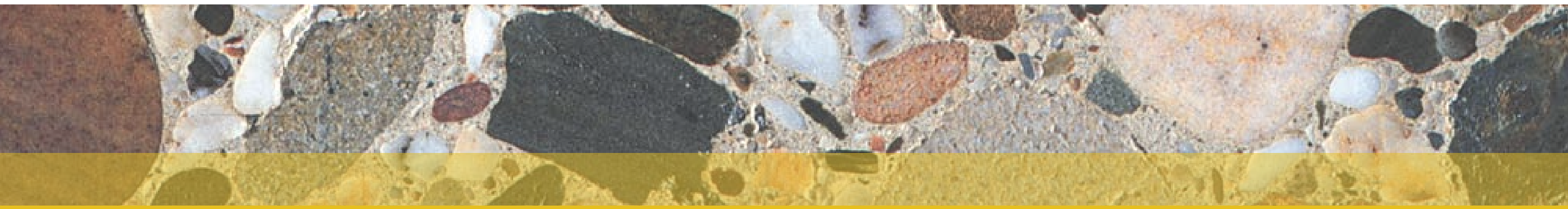
ecra

european cement research academy



3 / 2011

NEWSLETTER

Contents

Next ECRA events:

- Cement and Admixtures
  9 November 2011
- Clinker and Cement Production
  23–25 November 2011

Air-entraining admixtures – the working mechanisms

The influence of mixing time, type and the addition level of admixtures on air void formation

Concrete with resistance to freeze-thaw with de-icing salt must have an air-entraining agent which generates a sufficient quantity of small air voids in the hardened concrete. The basic materials used are soaps from natural resin (vinsol resin) and to a growing extent synthetic active ingredients (alkylpolyglycolether sulfates and alkyl sulfates or alkyl sulfonates). During the mixing process, some molecules arrange themselves around air bubbles. Others are sorbed to cement particles. Air bubbles can thus adhere to solid particles and the stability of the air void system is improved. Further molecules are precipitated in the pore solution.

New air voids are formed continually during the mixing process and the air content rises. Air void formation ends when there is no more air-entraining agent present in the pore solution. Different mixing times depending on the nature and the addition quantity of the air-entraining agent are needed to ensure that the air-entraining agent is completely activated. From some construction sites it was reported that the air void content of the hardened road concrete was considerably higher than planned, especially when air-entraining agents based on synthetic active constituents had been used.

Research programme results

Investigations were conducted with pure chemical substances: a natural resin (vinsol resin) and three synthetic active agents (alkylpolyglycolether sulfate, alkyl sulfate and alkyl sulfonate). The air void formation in concrete was determined as a function of mixing time with the quantity of substance determined in a preliminary test to achieve an air content of about 5 vol. % (normal quantity), and the double and threefold quantity (**Fig. 1a–1d**). With the normal addition quantity the concretes exhibited virtually identical behaviour with all substances. The air content rose after a short mixing time to about 5 vol. % and there was then no further significant change with increasing mixing time. Differences between the active agents were detected with double or threefold the addition quantity.

The behaviour of the air-entraining substances could be assigned to three groups according to the type of active agent. With concretes made with admixtures based on natural active agents (group 1), the air contents increased only 3 to 5 vol. % to about 8 to 10 vol. %. After a mixing time of about 2 minutes at most there were no further changes in air content. With concretes made with the threefold quantity of synthetic active agents alkyl sulfate or alkyl sulfonate (group 2) the air content increased by a factor of three to about 15 vol. %. In concretes made with the synthetic active agent alkylpolyglycolether sulfate (group 3) air content increased to 30 vol. %. Significantly longer mixing times were also necessary for admixtures of group 2 or 3 before the air-entraining substances were fully activated and a constant air content was obtained.

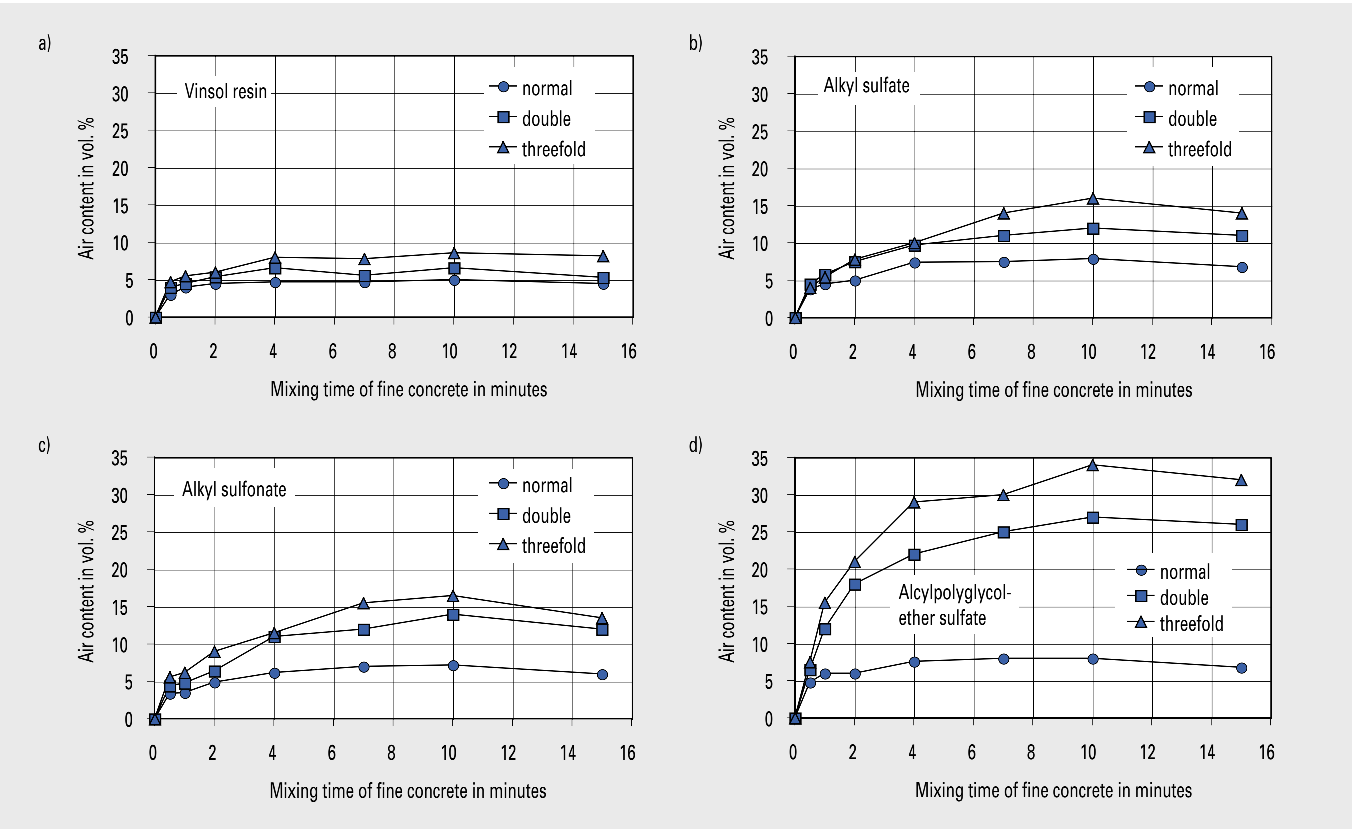


Fig. 1a–1d: Air void formation in relation to the mixing time and the addition level of the active agent (normal dosage: addition level to achieve 5 vol. % after 2 minutes mixing time).

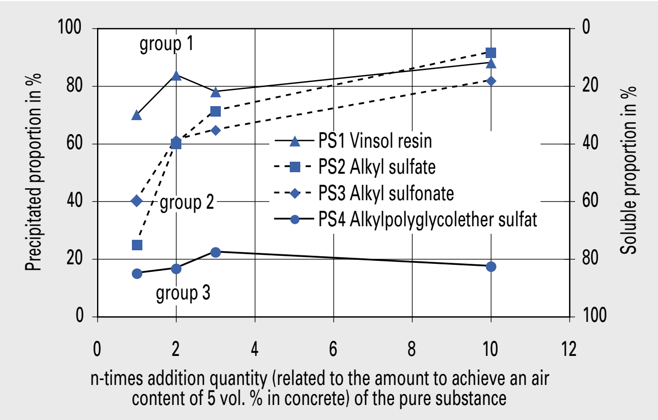


Fig. 2: Proportion of precipitated (dissolved) active agent in a calcium hydroxide solution as a function of the addition level (subsequent activation potential low: group 1, middle: group 2, high: group 3).

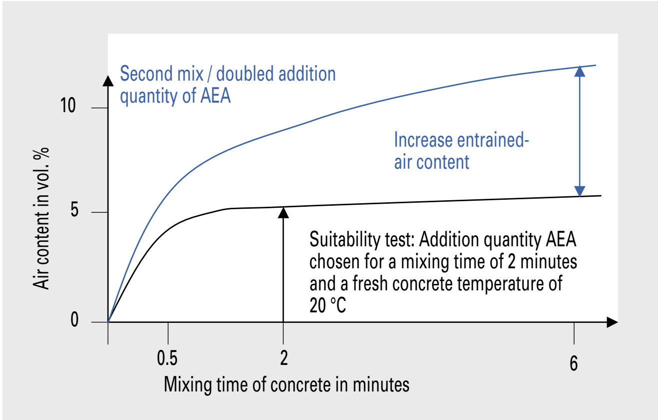


Fig. 3: Testing the subsequent activation potential of a concrete in laboratory tests.

The different behaviour is caused by the fact that the proportion of the active agent dissolved in the mixing water changes depending on the chemical composition of the admixture (**Fig. 2**). In spite of a high addition quantity of wood resin (a natural active agent) only a small residue is left in solution. There is only a slight increase in the air content and the subsequent activation potential can be classified as low (group 1). With the synthetic active agents alkyl sulfate and alkyl sulfonate a "medium" amount remains in solution. There is a corresponding medium increase in air content and a medium subsequent activation potential (group 2). The active agent alkylpolyglycolether sulfate, which has the highest solubility in the pore solution, therefore exhibits a high subsequent activation potential (group 3).

Additional tests with commercial air-entrainers with known active agents showed identical results. A substantial increase in air content occurs only when a synthetic AEA has been used. As a consequence of a shortened mixing time during production, excess air-entraining agent has been added to the fresh concrete to achieve the desired air content. The fresh concrete then contains inadequately activated air-entrainer. The air void content may increase if mixing energy is subsequently applied during placement.

A practical recommendation

To avoid excessive air content in future it is recommended that the quantity of air-entraining agent determined in the performance test should be doubled in an additional test, and the air content of the mixes with both addition quantities of air-entraining agent should be measured after a short mixing time of, for example, 30 seconds (depending on the mixing effect of the mixer), and after an extended mixing time of about four to six minutes (**Fig. 3**). If there is a substantial rise in the air content with the double addition quantity and extended mixing time there is a high risk of a subsequent rise in the air content of the fresh concrete during construction work.

Future learning and knowledge-sharing – ECRA training courses

The combination of classroom training and e-learning is an efficient tool for education

Since the global demand for cement is predicted to almost double by 2050 and the industry is facing increasing challenges, one of which is certainly the training and education of young engineers, technicians and kiln operators, ECRA is aiming to help more and more international companies run their plants more efficiently and safely. This also implies that cement producers are investing in improving, securing and updating the knowledge and fundamental skills of their personnel. The aim of the newly developed ECRA training courses is to serve as a central point of information regarding the basic and advanced knowledge in cement production. The topics of the courses will cover all aspects from raw material handling and grinding to quality management processes. Due to the combination of classroom and online training, the courses ensure an efficient way of learning. In the near future new formats will also be developed to make advanced training even more effective.

The global cement industry is striving to reduce its energy consumption and material demands as much as possible while at the same time the demand for cement worldwide is growing. This leaves the industry with a new challenge in the coming years: the recruiting and training of young engineers and scientists who will operate the plants and maintain high quality cement production. Investment in education and training results directly or indirectly in increased plant availability or quality and cost improvement. In all cases, these training programmes have to be customised to suit the operational requirements of the specific plant and the individual needs of the employees to be trained. Due to the growing cement market, the increasing number of un- and semiskilled workers and the loss of experience due to demographic developments,

Fig. 1: Internet-based learning is an effective element of classroom training.

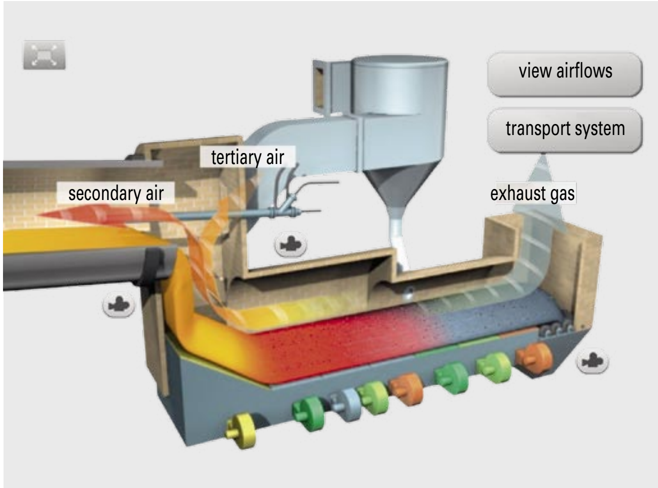


Fig. 2: An animated illustration of a clinker cooler.

the necessity for efficient and time and cost saving cement training is essential. ECRA has therefore developed an efficient and customized training programme for cement producers with a combination of internet based online training and classroom training. The first of these training courses, "Clinker and Cement Production" which takes place in November this year will cover the basic aspects of clinker burning and grinding technologies.

Highly efficient training through e-learning

Starting with the first training course, ECRA will be embedding elements of the cement online courses of the Research Institute into classical training programmes. The online courses cover all aspects of cement production from the quarry to shipping and environmental issues. They are mainly addressed to un- or semi-skilled personnel. The modular structure of the online courses makes it easy for the learner to work through a single course within 1–2 hours. If disturbed during self-paced learning, learners can continue where they left off or repeat or skip specific parts of the training. In general online training is less expensive compared to face to face training as it helps save time and cut travel expenses.

Combination of web based and classroom training successful

Through the internet-based format, the courses of the Research Institute provide several benefits compared to traditional classroom training. They can be used individually, as well as embedded into blended learning activities (such as classroom training).

Particularly in technical trainings, in courses for foremen and control room operators or during the education of unskilled employees, online courses can be implemented in the working plan. For example, in different technical trainings delivered as daily or weekly classroom sessions it has proved very effective and successful to implement the online platform within the time schedule of the trainings (**Fig. 1**). It could be used for the preparation of different topics, for homework or as a tool during the training session. Because of the different levels of the online courses, individual courses were implemented for trainings given at entry and advanced level. The online courses were also successfully integrated into expert workshops.

Experiences

Experiences with the new format show that the acceptance of online courses is high. The animations and illustrations (**Fig. 2**) are especially helpful for the users. However, online training needs promotion within companies, since the technical infrastructure must be available and the conditions for the usage of the platform need to be communicated. Nevertheless web-based training has many advantages:

- Learners can access the courses whenever they have free time and from any place where they have internet access.
- Since a learning management system controls the learning process and saves all the steps a learner takes, he can easily continue the course from the last topic visited.
- Learners can work through the courses at their own speed. They can search the courses and learn only the topics they actually need or are interested in.
- Learners can easily check and verify their knowledge through computer based tests.
- The courses can be scaled up easily for whole plants or whole companies and are not limited to the availability of rooms, time slots, subject experts or trainers.
- E-learning provides economic benefits, such as cuts in travel expenses, reduced costs for trainers and less off-time.

Future Outlook

In addition to the existing training courses and the use of the E-learning platform during the courses, new formats (such as Web 2.0), will be developed in the future, in order to make advanced training more efficient. In this context, web-based training could be supplemented by live online training or on site classroom sessions to deliver both basic and advanced knowledge as well as vendor neutral experience.

ecra
european cement research academy

European Cement Research Academy

Tannenstr. 2 · 40476 Duesseldorf
P.O. Box 30 03 32 · 40403 Duesseldorf
Germany

Phone: +49 (0)211 2 39 83 8-0
Fax: +49 (0)211 2 39 83 8-500

info@ecra-online.org
www.ecra-online.org