

A new generation of bitumen emulsions with rapid cohesion build-up

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Abstract

In order to extend still further the applications of spraying and coating bitumen emulsions, Colas has developed a new generation of emulsion with rapid cohesion build-up. These emulsions are manufactured at atmospheric pressure by a straightforward procedure and have droplet size distributions which are considerably better than those of conventional emulsions, in particular:

- the median diameter is reduced,
- the standard deviation is lower.

Largely as a result of these characteristics, the principal properties of these emulsions are particularly interesting and appreciated by users for surface dressings and spraying applications in general. These emulsions have much higher viscosity and much faster cohesion build-up. Among other things, these two factors mean the emulsions do not run in the case of sloping pavements, that the road can be opened quickly to traffic and that surface dressings can be placed without risk, in particular single surface dressings which require a higher proportion of binder.

This paper sets out the principal properties of this new generation of emulsion, the test for characterizing cohesion build-up in situ which Colas has developed in order to reveal this fundamental property and, last, the projects which have been performed on experimental worksites.

1. Introduction

Colas has developed a new generation of emulsions with rapid cohesion build-up using a simple and inexpensive emulsion manufacturing procedure.

The prime objective was to ensure that surface dressings achieve adequate strength for safe reopening to traffic rapidly without a large number of loose chippings, thereby making the road surfacing invulnerable to bad weather shortly after laying.

As a consequence, single surface dressings, which have a high binder content, can at last be manufactured with emulsions instead of fluxed bitumen.

Their high viscosity also means they do not run on sloping pavements while retaining their adhesion and wetting power with respect to the chippings and the substrate.

This new range of emulsions is manufactured at atmospheric pressure using conventional homogenizers that are available in the Colas Group's factories.

In order to highlight their performance with regard to cohesion build-up, specific laboratory and worksite tests have been developed. These tests are particularly discriminating and clearly show the benefit of these emulsions which rapidly fix the aggregate and provide the surface dressing with the characteristics it requires to withstand traffic.

After a brief description of the manufacturing procedure, the main properties of the new emulsions are described and the results of the tests performed to characterize their cohesion build-up are given.

2. The manufacturing procedure for emulsions with rapid cohesion build-up

The aim of the new manufacturing procedure is to improve all the properties of emulsions. Either continuous or sequential mixing plants can be used.

The procedure is simple, but original and specific to this company. It is patented, so it will not be described here. It has the advantage of not requiring pressure or a cooler and is economical.

The bitumen emulsions are cationic and manufactured at atmospheric pressure using the conventional homogenizers owned by Colas. The manufacturing temperature is the same as for conventional emulsions and, obviously, considerably below 100°C. This new generation of emulsions can be easily manufactured in the group's mixing plants after a simple modification.

Depending on their use, the bitumen content of the emulsions can vary between 60 and 70%. They use the usual emulsifiers and other additives are not required. They are stored in the same way as conventional emulsions.

3. The main characteristics of the new generation of emulsions

The manufacturing procedure for these emulsions considerably changes the bitumen droplet size distribution. The dispersion of diameters is greatly reduced. This results in a marked reduction in the standard deviation of the distribution compared with a conventional emulsion manufactured with identical components and an identical formulation and, of course, the same homogenizer under similar temperature conditions. In addition, the median droplet diameter can also be reduced, but this change depends on how the homogenizer is adjusted and the bitumen which is used. Figure 1 shows the droplet size distributions of two emulsions with a 65% bitumen content as measured with a laser granulometer. These plots clearly show the reductions.

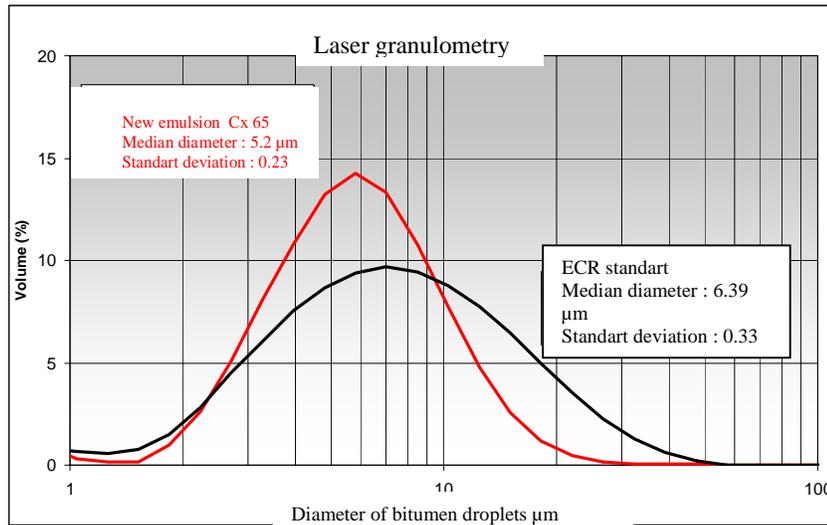


Figure 1: droplet size distribution of the new emulsion with a 65% bitumen content compared with a control emulsion manufactured under the same conditions.

The consequences of a "closer" droplet size distribution have already been described in several papers (1,2,3):

- clear increase in viscosity,
- more rapid cohesion build-up.

The diagrams in Figure 2 show that the viscosities of the emulsions with 65 and 69% binder contents are increased by a factor of between at least 2 to more than 5.

The viscosities at 25°C are expressed in mPa.s, and were obtained from a flow measurement.

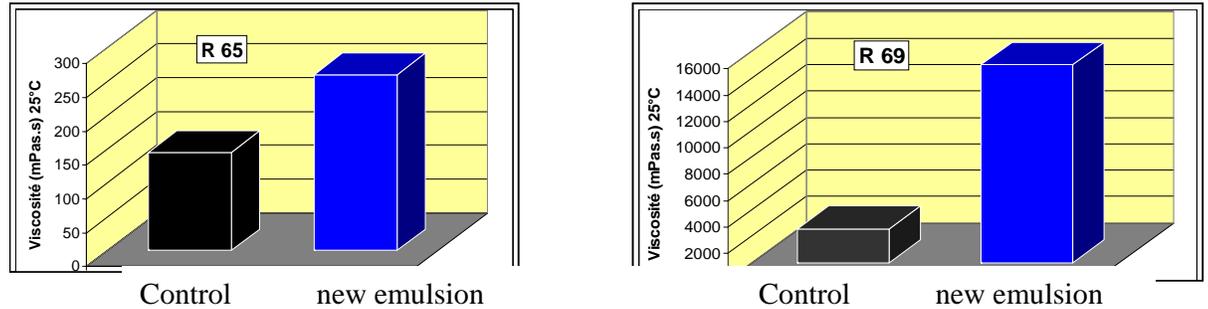


Figure 2: comparative change in viscosity at 25°C of the new emulsions with 65 and 69% bitumen contents in relation to the control emulsions.

Table 1 below sets out the other characteristics of the new emulsions in comparison with those of the control emulsions with the same bitumen content and manufactured under similar conditions.

Emulsions with bitumen content of 65%		Standard	Unit	New Cx 65	Control (C 65 B 3)
Emulsion polarity		EN 1430		Positive	
Binder content (based on water content)		EN 1428	%(m/m)	65	
Homogeneity With a screen	Retained on 0.500 mm screen	EN 1429	%(m/m)	0.01	0.03
	Retained on 0.160 mm			0.02	0.18
Storage stability	Retained on 0.500 mm screen	EN 1429	%(m/m)	0.01	0.04
	Retained on 0.160 mm screen mm			0.03	0.2
Breaking value		EN 13075	(g)	80	85
Adhesion		EN 13614	(%)	90	75
Bitumen class		EN 1426	(1/10mm)	160/220	

Table 1: Other characteristics of the new Cx 65 emulsion and the control emulsion

These conventional measurements have been supplemented by the results of the tests specifically developed by Colas to show the rate of cohesion build-up in the laboratory and under real worksite conditions.

4. Characterization of the cohesion build-up of emulsions in the laboratory and in situ

4.1 Cohesion build-up of emulsions in the laboratory

This test involves applying a rubber block under specified conditions to three circular specimens of fresh single surface dressing manufactured with the emulsion to be tested and the chippings to be used at the worksite. A specific apparatus has been developed for this test. The amount of chippings which remain fixed to the specimen after this test is measured and expressed in a percentage by mass. A specific test procedure has been developed in order to control the test conditions and ensure reliability (repeatability and reproducibility).

The graph in Figure 4 shows that the cohesion build-up of a new emulsion is considerably faster than that of the control emulsion, with all formulation parameters constant.

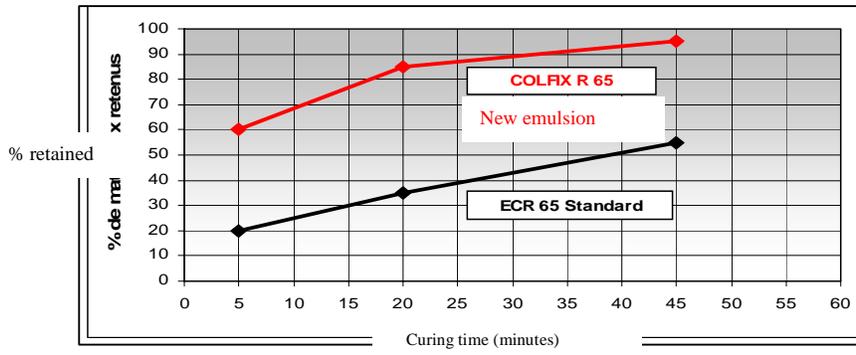


Figure 4: Cohesion build-up of the new emulsion in comparison to the control emulsion.

4.2 Cohesion build-up on the worksite

A test of a similar type has been developed for use under real worksite conditions. It involves placing test plates on the pavement to be surfaced and applying a surface dressing to them, as shown in the photos in Figures 5 and 6.



Figures 5 and 6: test plates before and after application of chippings

These test plates are removed after the chippings have been applied and conserved for fixed periods of time, generally 5, 20 and 45 minutes.

“Cohesion build-up” is assessed by measuring the weight loss that results from the loss of chippings when the plates are turned upside down. The amount of chippings that remain fixed at the end of this test is expressed as a percentage. It is representative of the cohesion of the binder at the time of measurement.

After the cohesion build-up test, the test plates after each of the periods of time are immersed in water.

The colour of the rinsing water is rated on a basis of a colour chart drawn up in the laboratory.

Very clear rinsing water receives a higher mark which indicates good binder cohesion.

Figures 7 and 8 show the influence of the new manufacturing procedure on the rate of cohesion build-up for the emulsions in question.

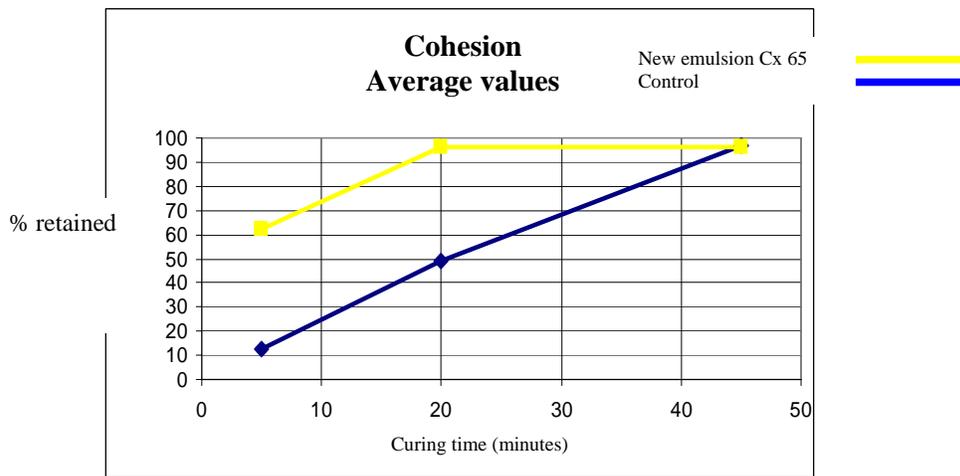


Figure 7: cohesion build-up of the new Cx65 emulsion compared with the control emulsion

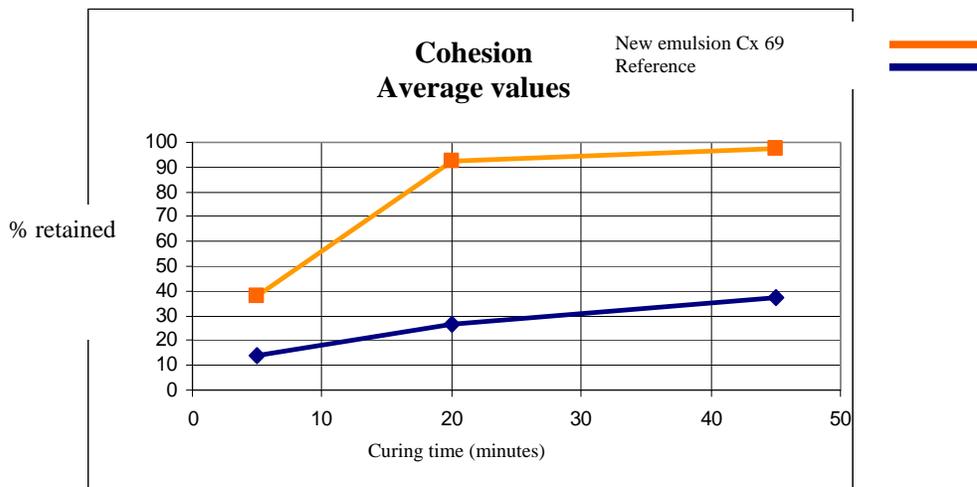


Figure 8: cohesion build-up of the new Cx69 emulsion compared with the control emulsion

The rate of cohesion build-up for these emulsions is always faster, particularly so in the first minutes[Problème en français]. Until now this has been a major drawback for emulsions which acquire cohesion considerably more slowly than fluxed bitumens. For example, 5 minutes after placement, the new Cx69 emulsion provides a level of cohesion which is achieved only after 45 minutes with the ECR69 control emulsion.

These results open up possibilities for the manufacture of surface dressings, in particular single surface dressings, which can be rapidly reopened to traffic with sufficient strength to avoid loose chippings thus limiting disruption to road users.

5. Conclusion

High performance bitumen emulsions have been obtained at atmospheric pressure using a straightforward and economical procedure.

Their rheological characteristics, particularly their high viscosity, combined with rapid cohesion build-up mean that the use of additives can be avoided and, above all, allow more controlled manufacture of surface dressings thus limiting disruption to traffic.

New laboratory and in situ tests have been developed in order to demonstrate, particularly under worksite conditions, the cohesion build-up of these new emulsions in relation to control emulsions manufactured in the conventional way with the same ingredients.

These properties provide very valuable benefits: no running during spraying and the possibility of using higher proportions of binder in a layer without any risk. It is therefore possible to consider using these emulsions for single surface dressings which are usually the preserve of fluxed bitumens. They can also be used without any problem on slopes. Furthermore, adhesion to the aggregate and the substrate are maintained or even improved.

The binder's rapid cohesion build-up means that it can be opened to traffic more rapidly and without any danger of excessive amounts of loose chippings are poorly bonded to the substrate because the binder is still fragile. It also greatly reduces the consequences of poor weather immediately after placement.

Bibliography

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