SETSIT® 5 Accelerator
Activated Liquid Dithiocarbamate Accelerator

Most people in the latex industry are familiar with **BUTYL NAMATE®** Accelerator (NaDBC). It is recognized as the liquid alternative to **BUTYL ZIMATE®** Accelerator (ZDBC), the industry's water-insoluble, workhorse accelerator. Unfortunately, some people are unaware of the fact that this is not the only water-based alternative. There is another world of chemistry that deals with activated liquid dithiocarbamate accelerators for latex, and distinguished by its performance and flexibility in latex compounds.

SETSIT® 5 Accelerator is a liquid dithiocarbamate that includes water-miscible or water-soluble ultra accelerators. This means that in both natural and synthetic latexes, this product promotes rapid cures, providing a rate and state of cure that is comparable to **BUTYL ZIMATE**. This product is extremely easy to use since it does not require dispersion or emulsification. It is also freeze/thaw stable, which eliminates shipping concerns over the winter months.

The Study

For this study Natural Rubber Latex (NRL) was selected. Synthetic latexes, while generally slower to cure than NRL, are expected to respond to these accelerators in a relative manner. The base compound for this study is as follows:

Table 1: The Base Compound

	WET (phr)
62% High Ammonia Natural Rubber Latex	161.0
10% Potassium Hydroxide	5.0
5% Potassium Caseinate	10.0
50% Sulfur Dispersion	2.0
50% **Zinc Oxide Dispersion**	6.0
50% **AGERITE® STALITE®** Antioxidant	2.6
Accelerator	**Variable**

Please note that this formula is written in wet phr rather than the usual dry phr. This is because the exact concentration of **SETSIT** accelerators is considered proprietary. The compounds were mixed without the use of any surfactants due to the fact that in some cases tensile strengths are lower when these are used. The compounds were cast on glass plates, air dried, stripped, oven dried, and cured in a circulating hot air oven for 20 minutes at 93.3°C (200°F). The films were then tested following the standard 24 hour ASTM waiting period.

Optimum Accelerator Levels

Determining the optimum accelerator level was the first step in this study. Using the base compound given in Table 1, ranges of each of the accelerators were used and vulcanized for 20 minutes at 93°C. These films were then tested, and the results were plotted on a graph in order to determine the maximum tensile strength. Although not always considered optimal due to aging considerations, the amount of accelerator used to achieve a maximum tensile strength will be considered the optimal accelerator level.

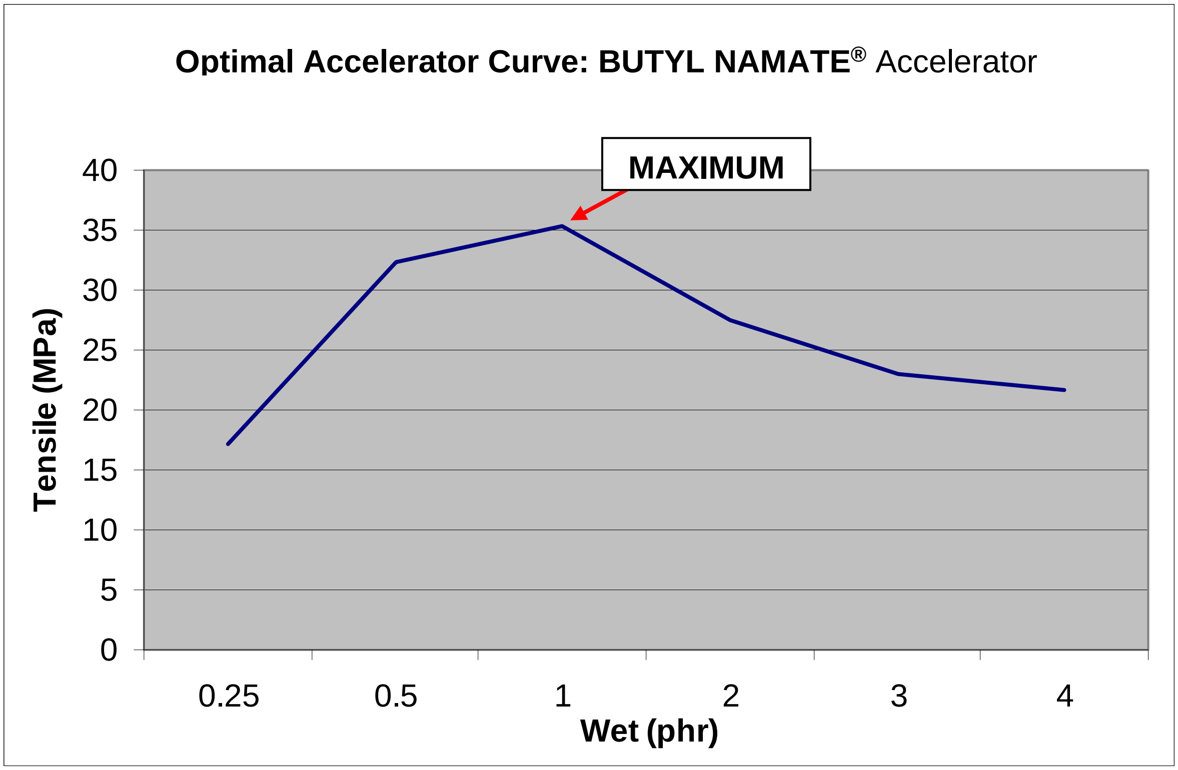

Figure 1: BUTYL NAMATE Optimal Accelerator Level

For **BUTYL NAMATE®** Accelerator, it is easy to determine the optimal accelerator level since there is a clear maximum tensile strength.

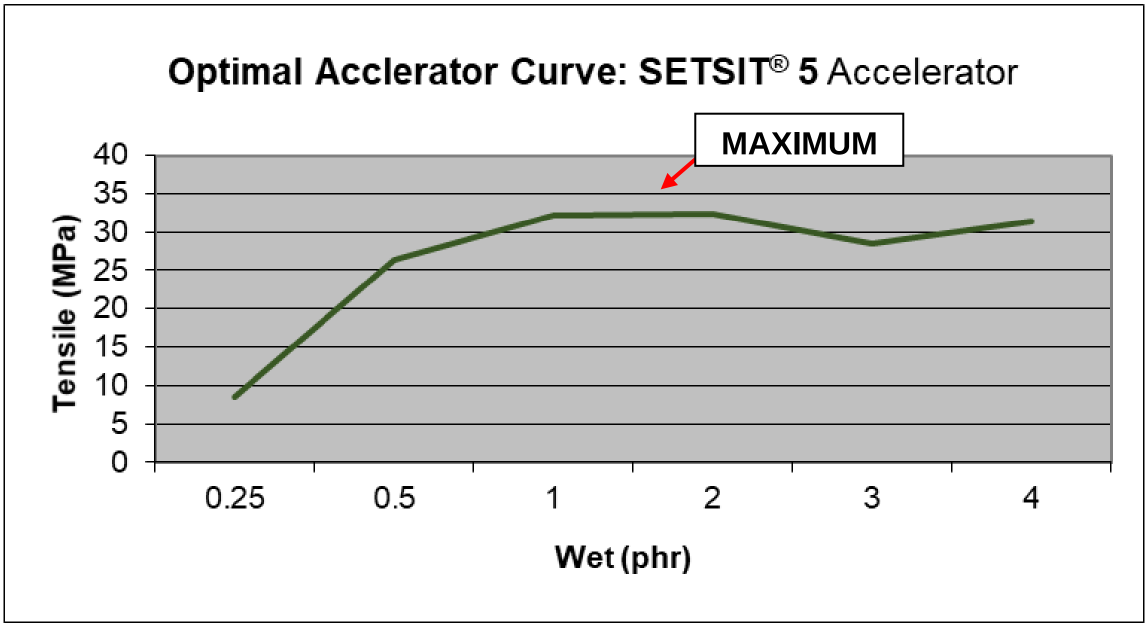

Figure 2: SETSIT® 5 Optimal Accelerator Level

For **SETSIT® 5** Accelerator, it is not as easy to determine the maximum tensile strength. Since the results for 1 phr and 2 phr are essentially equivalent, it is safe to assume that the optimal accelerator level is somewhere between these two levels.

Instead of displaying similar figures for each individual accelerator, Table 2 summarizes the optimum and acceptable range for each of the accelerators.

Table 2: Optimum Accelerator Levels

Accelerator	Optimum Accelerator Level (wet phr)	Acceptable Range (wet phr)
BUTYL NAMATE® Accelerator	1.0	0.5 – 2.0
SETSIT® 5 Accelerator	1.5	1.0 – 4.0
BUTYL ZIMATE® Accelerator	2.0	0.5 – 3.0

Room Temperature Curing

For this evaluation, samples were coated as above, but rather than placing the films in a circulating hot oven for vulcanization, the films were allowed to cure over a period of time at room temperature. Room temperature is generally recognized as 72°F (22.2°C). By allowing the samples to vulcanize at room temperature, their relative speed will be determined. Each sample was made with 1 phr wet of accelerator.

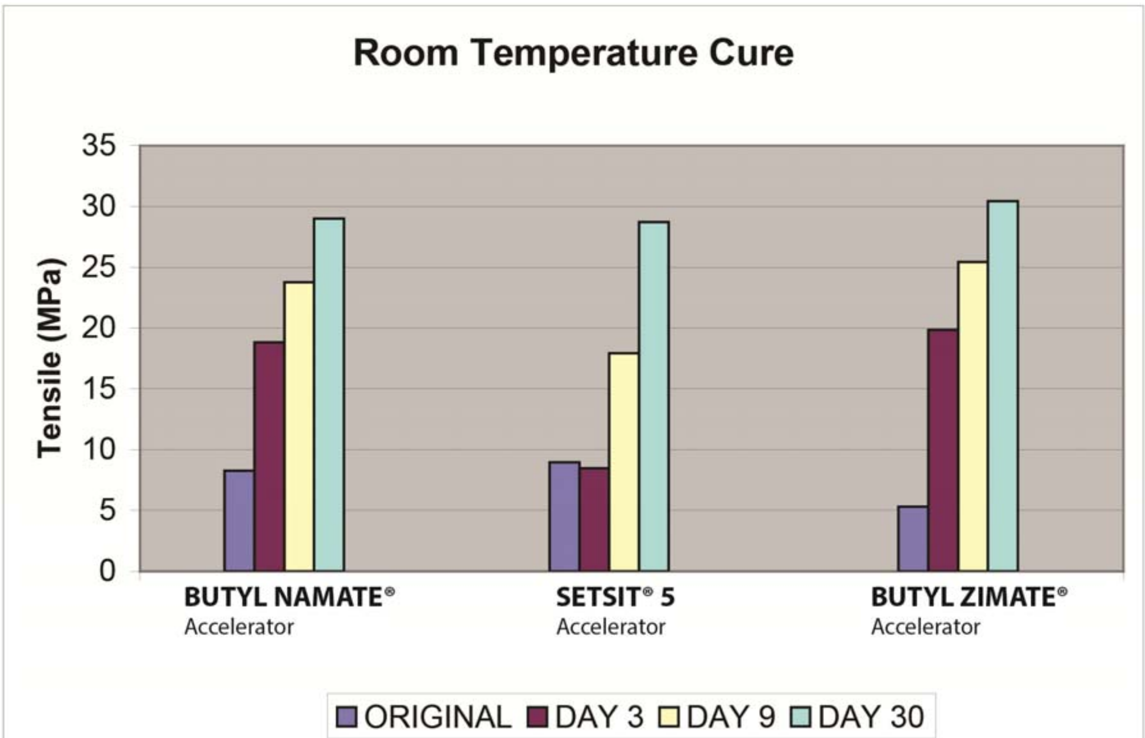

Figure 3: Room Temperature Cure

It is clear from this chart that all of the accelerators produce a similar state of cure originally and after 30 days. The differences are seen at 3 days and 9 days. After 3 days at room temperature, two of the samples have already exceeded 14MPa (**BUTYL NAMATE®** Accelerator and **BUTYL ZIMATE®** Accelerator). These accelerators have a faster rate of cure than the last accelerator (**SETSIT 5**).

The Five Minute Cure

So far it has been shown that all of the accelerators included in this study will cure a latex film at room temperature and in a circulating oven, which demonstrates that vulcanization is not a static process. The next logical step in this study was to look at what happens when a combination of room temperature and hot air vulcanization is used.

The Five Minute Cure was devised to answer this question. Instead of curing the latex films for 20 minutes at 93°C, they were cured for only 5 minutes at 93°C. The films were then kept at room temperature for 30 days, and were tested periodically to note any increase in the state of cure as time passed. These films were made using the Optimum Accelerator Level shown in Table 2.

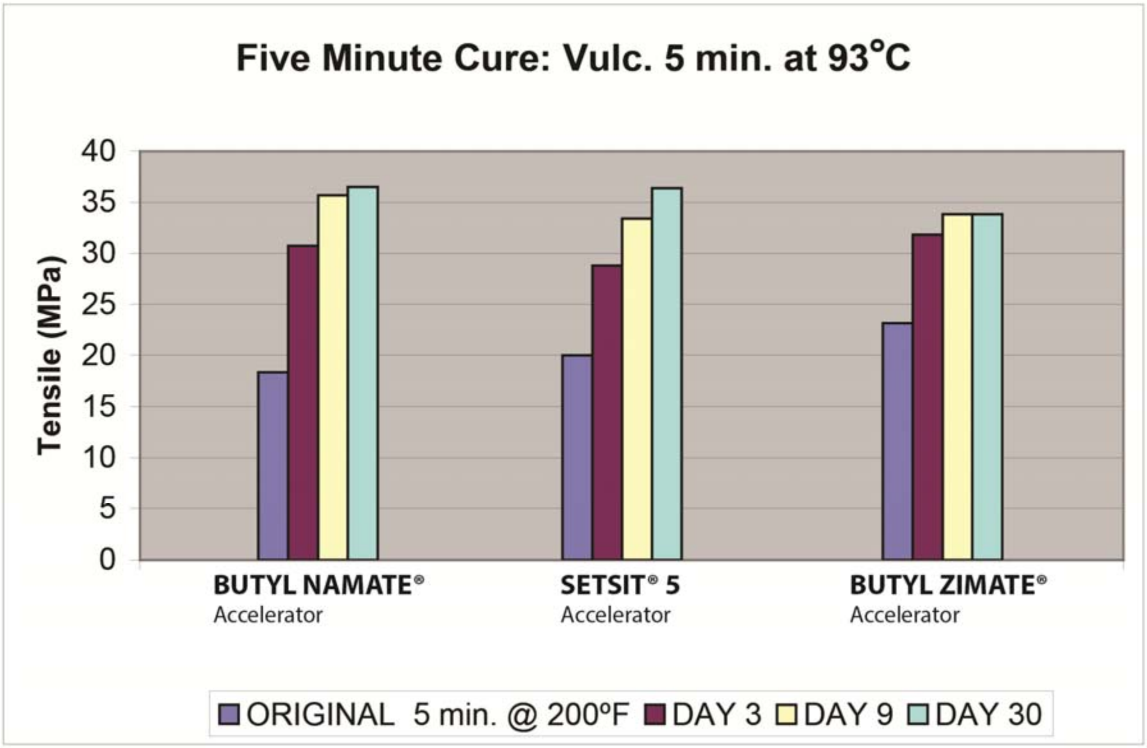

Figure 4: The Five Minute Cure

Figure 4 shows that the Five Minute Cure gives us the best of both worlds. After only 9 days at room temperature, the state of cure is comparable to a full oven cure of 20 minutes at 93°F. This saves 15 minutes on the cure cycle, which not only increases production speeds, but decreases the use of energy. Given the ever-increasing cost of production, the Five Minute Cure in combination with the use of **SETSIT® 5** Accelerator is a great way to save money.

SETSIT® 5 facilitates compounding and delivers the high tensile strengths that are associated with **BUTYL ZIMATE®** slurries and dispersions. In addition, it allows for fast and accurate volume measurements, since it is more convenient to fill a glass container to a certain level than to weigh and transfer viscous dispersions.

Accelerators are frequently withheld from the mix until just before use; rapid incorporation of the liquid accelerator (SETSIT 5) expedites factory operations and provides a degree of flexibility. Manufacturers who pre-disperse ‘packages’ of zinc oxide, sulfur, antioxidant and accelerator are not able to adjust the level of accelerator to conform to line speeds, oven dwells, seasonal variations, etc.

Eliminating the accelerator from this dispersion ‘package’, and adding it separately, allows for larger ball mill or attritor batch sizes. The liquid product does not settle or separate. No remixing is necessary, and housekeeping is neat and clean.

Advantages

- High tensile strengths are easily attainable over a wide range of zinc oxide and sulfur levels. Low levels of accelerator deliver tensile strengths that surpass the minimum requirements of the Standard Malaysian Glove Scheme.
- No preparation or pre-processing is required.
- Accurate volumetric measurements are fast and easy.
- Housekeeping and storage are neat and clean.
- Liquid accelerators are freeze/thaw stable.
- **SETSIT® 5** can be rapidly incorporated into latex without mechanical shear. This eliminates agglomerates that cause hot spots and pinholes in films, and minimizes the possibility of mechanical destabilization of the compound.
- By eliminating the accelerator from the masterbatch, larger dispersion batches are possible. As a result, the state of cure can be modified by adjusting the level of liquid accelerator.
- Room temperature curing after oven cure allows for shorter oven dwells.

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