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STABILIZER CONCEPTS FOR SILANE CROSSLINKED POLYETHYLENE IN CABLE APPLICATIONS

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ABSTRACT

Silane crosslinked polyethylene is used for insulation of low voltage wire and cable. The stabilizer package needs to be balanced to allow effective grafting of vinyl silane via radical reaction on the polymer backbone and subsequent crosslinking of the silane groups under humid conditions. Additionally, it has to provide effective protection of the polymer from degradation and consequently maintains mechanical and electrical properties after processing and aging.

The current poster gives an overview about latest developments and discusses features and benefits of different stabilizer packages on

- *grafting yield*
- *crosslinking (ambient curing)*
- *heat aging (durability)*

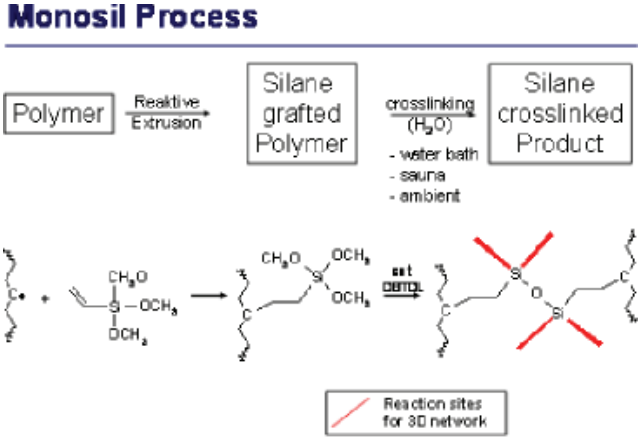
KEYWORDS

Monosil, Silane crosslinking, Radical reaction, Aging, Ambient curing, Stabilization,

MONOSIL PROCESS [2]:

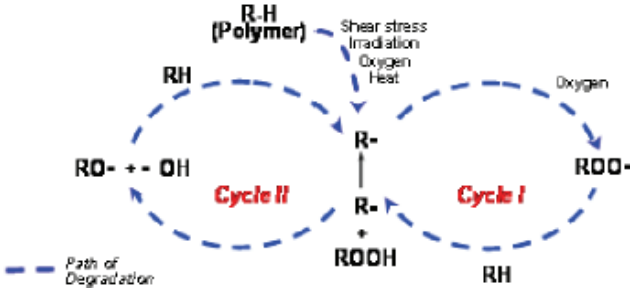
Vinyl silane is grafted via a reactive extrusion with peroxides as initiator on the polyethylene backbone. Reactive extrusion and form giving is done in one step.
The final article is exposed to humidity (storage in hot water bath, in Sauna or under ambient conditions). The methoxy Silane groups are hydrolyzed and crosslinked with the help of a crosslinking catalyst (Dibutyl tin dilaurate, DBTDL).

This subsequently forms a 3D network.



AGING (AUTOXIDATION)

During the aging process radicals are formed. These radicals are reacting very fast with oxygen dissolved in the polymer matrix. Hydroperoxide radicals are produced which can abstract a hydrogen radical from the polymer backbone and form hydroperoxides. These hydroperoxides are not stable. Heat, light and transition metals such as copper, iron, manganese, etc. [3] decompose these hydroperoxides and generate new radical species. The most important propagation reaction of this radical reaction is leading to chain scission of the macromolecules (ß-sission) of alkoxy radicals. These changes have immediate impact on mechanical properties and determine the service life of the cable insulation. [4]



Effective Antioxidants interfere with the radical species and deactivate the hydroperoxides and therefore suppress the autoxidation cycles to such an extend that extended durability can be achieved.

CHALLENGE

Both the Silane grafting step and the aging process are radical reactions. The stabilizer package has to allow an effective grafting (radical reaction) and at a later stage during service time of the application suppress effectively the aging process (radical reaction).
Additionally, during the crosslinking step (polycondensation reaction) it should behave neutral or at the best accelerate the crosslinking to allow ambient curing.

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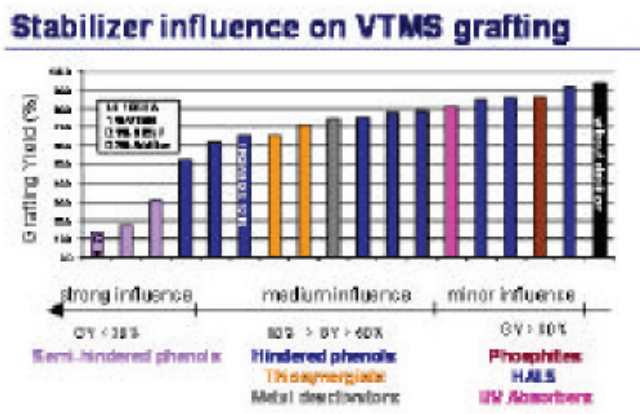
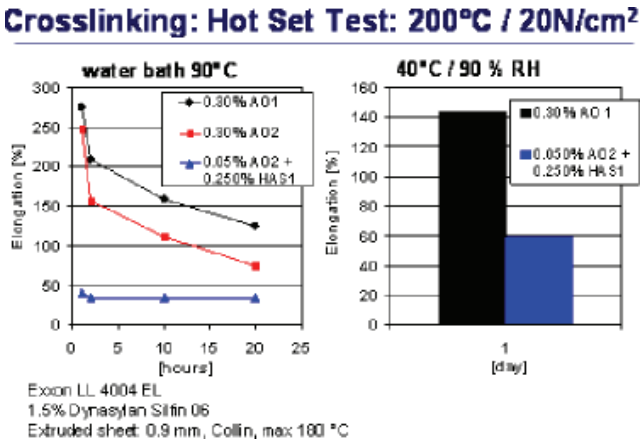


The grafting yield is strongly influenced by:

- stabilizer interaction with radical species
- stabilizer interaction with peroxides

Hindered Amine Stabilizers (HAS) show only moderate influence

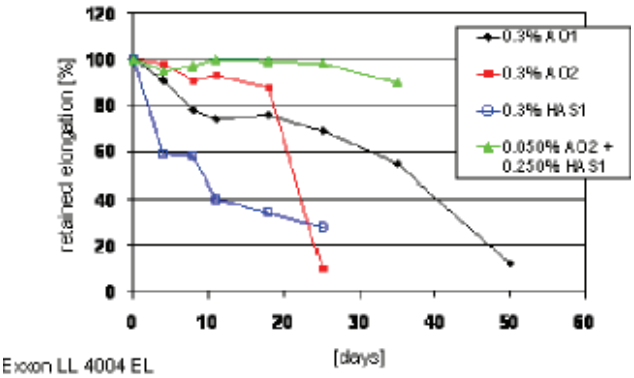


Exxon LL 4004 EL
1.5% Dynasylan Silfin 06
Extruded sheet: 0.9 mm, Collin, max 180 °C

Efficient crosslinking is affected by

- high grafting yield
- effective crosslinking catalyst

Specific HAS/AO mixtures show extremely good performance



Exxon LL 4004 EL
1.5% Dynasylan Silfin 06
Extruded sheet: Collin, max 180 °C, 0.9 mm

Durability (Aging properties) is given by

- high crosslinking density
- efficient stabilizer protection

Specific HAS/AO mixtures are very effective and superior compared to state of the art.

PERSPECTIVES

Specific HAS/AO mixtures allow

- Optimized Silane/Peroxide/Catalyst use
- Faster and more efficient crosslinking
- Improved durability (extended application fields)

REFERENCES

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[3] Hendrickson et al.: *Poly. Eng. Sci.* 1995, Vol. 35, p. 24

[4] Schwarzenbach et al., Plastics Additive Handbook, 2001, 3-9