RECIPNEU
Empresa Nacional de Reciclagem de Pneus, Lda

MEMO
Cryogenic Rubber infill for Artificial Grass sports fields: Comprehensive description of its superior Technical Features

1. RECIPNEU is a major producer of rubber granulates, located in Sines Industrial Park, Portugal, and has experience since 2001 in the production of cryogenic rubber granulates for rubber infills in artificial sport fields, with many supplies in Europe, USA, Africa and Middle East for major prestigious Football clubs, being some FIFA recommended, and following FIFA and UEFA standard testing procedures.

2. The technology installed at RECIPNEU plant is the primary cryogenic process, with a production capacity of more than 2 ton/hour of clean rubber granulate, equivalent to 15.000 ton/year of granulates. In this process, the rubber from tyre chips is submitted during enough time in a cryogenic tunnel to temperatures of about – 80ºC (in contact with liquid nitrogen at –196ºC) to surpass the "glass transition point" of all the rubber polymers; immediately after, the chips enter in hammer mills with a very high impact energy, and in a fraction of a second is done the rubber grinding by a sharp and strong impact, breaking the "glassy" rubber and obtaining all the final rubber granulates.

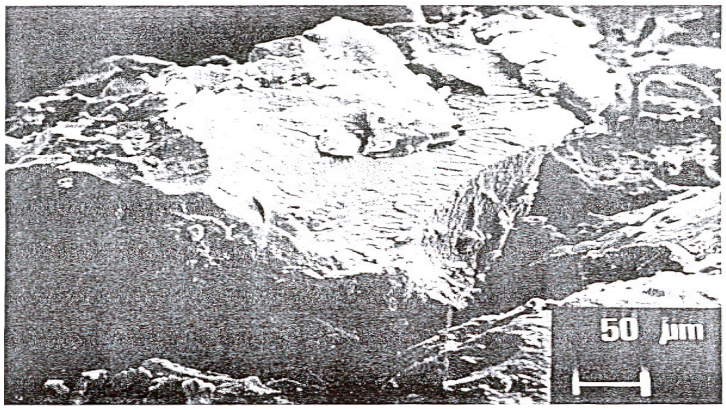
3. This grinding technology, innovative in Europe, produces rubber granulates with a superior quality and performance for the very demanding aplication as rubber infill in artificial grass for sports fields. The technical reasons inherent to our cryogenic process that lead to these superior features are:

    a) the very low grinding temperature in the rubber material (cryogenic – 80ºC);
    b) the very short time of the grinding operation (miliseconds); and
    c) the inert (nitrogen) atmosphere during cryogenic cooling and milling.

4. Under these grinding conditions, the resulting "cryogenic" rubber particles do show:

    - no thermal or chemical degradation in the polymer chains of the rubber;
    - flat morphology of the fracture surfaces obtained in the particle;
    - surface of the particles show practically no pores – regular "cuboid" shaped "glassy" particles, a kind of a "closed" particle, having the lowest specific surface area activity;
    - behaviour like an encapsulated particle – minimum leachates, odour, volatiles liberation, etc. (in fact, cryogenic rubber is practically odour free);
    - compliance with recent FIFA requirement on ageing resistance test.

5. Below an electronic micrograph photo of a cryogenic rubber particle ("cuboid" type):



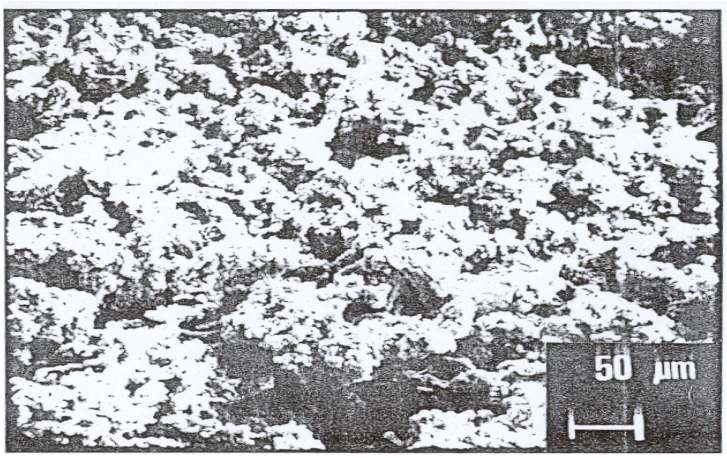
6. This “cuboid type” morphology in the cryogenic rubber particle shows basically flat surfaces, in geometrical type regular solid shapes - this is responsible for excellent water drainage, due to the high voids content in the rubber layer of the rubber infill; and almost no pores on the surfaces are found, therefore the particle is a kind of a “closed” particle, thus the superficial area of the cryogenic particle is minimum – this is responsible for a behaviour like in an “encapsulated” particle, not interacting/exchanging very much with the exterior (negligible volatiles – smell – or leachates are emitted from the particle); and also the absence of pores avoid physical adsorption of the air on the surface, being minimum the apparent volume of the (particle + adsorbed micro air bubbles), or maximum the apparent density – and no floating in the water is observed, so the rubber is stable in place (no significant rubber losses with time, therefore practically no need of refills in later years).

7. By the contrary, in the conventional mechanical grinding process, with high applied friction / shear / abrasion forces for size reduction, the grinding conditions are exactly the oposite (extremely high grinding temperature and pressure, long grinding times, and in the presence of oxygen from the air).

8. Under this “rubber cooking” conditions, inherent to all the mechanical processes, with severe oxidative and pressure heating conditions, the resulting characteristics for the rubber are as follows:

    - rubber particles suffer significant chemical degradation (scission of macromolecules and breakage of sulphur bonds to lower molecular weights, significant oxidative and thermal degradation, etc.), then elastic and shock abortion properties are reduced;
    - many irregular particle shapes are obtained, which collapses the void spaces in the rubber layer, giving a poor rain water drainage due to compactation;
    - too much undesirable black powder (highly staining) covers the rubber particles
    - rubber particles show a very high pore density (“spongeous” surfaces);
    - behaviour is like “open” particles, originating significant smell, leachates, and liberation of volatile ingredients (oils and sulphur) from the interior of the particle, that interacts and deplete UV protection in the polymer extruded films of the artificial grass.

9. Electronic micrograph photo of a mechanical ground rubber particle (“spongeous” type morphology), very explanatory:



10. Environmental impacts - leachate emissions of zinc, heavy metals, diluted organic carbon (DOC), and extractable halogen compounds (EOX) - from RECIPNEU cryogenic rubber granulates comply with the standard DIN V 18035-7. This fact is a “sine qua non” condition for official permits in many countries, and reveals the superior quality of RECIPNEU products (the mechanically obtained rubber granulates are in many cases out of compliance with that standard, then cannot be used).

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Also RECIPNEU rubber infill complies with more recent and demanding environmental regulations, namely in what concerns the release of PAHs.

11. The main features of RECIPNEU cryogenic granulates concerning rubber infill aplications are:

- no rubber smell (very important for "indoors");
- no black powder staining to the skin, sport dressings, etc.;
- good elastic properties (prompt rubber recovery due to non degradation of polymer chains);
- excellent rain water drainage (rubber layers don't block due to "cuboid" shape high voids);
- higher apparent density (no air bubbles traped / adsorbed on surface pores);
- higher stability in place (no rain water floating and displacement with water flow);
- environmental compliance with standard DIN V 18035-7 (zinc leachates, heavy metals, etc.);
- no significant rubber volatiles emission (due to minimum pore superficial area, behaves as a "closed" or "encapsulated" particle) to cause depletion in the UV resistance of plastic grass;
- longer durability of synthetic grass under strong UV radiation (enhancement of UV filters protection, due to minimum volatiles interaction (oils, sulfur scission) from the cryogenic "closed" particles).

12. Many significant and well known references of sport surfaces done with RECIPNEU cryogenic rubber infill since 2001 in Europe and Middle East are, amongst many others in Portugal, Spain, France, Ireland, U.K., Sweden. Norway, Greece, Middle East and Asia:

    Chelsea; Manchester F.C.; Liverpool; Arsenal;; Glasgow Rangers; Aston Villa (U.K.);
    Euro Disney Paris (France); Ankara National Stadium (Turkey); Lujzniki Stadium, Moskow (Russia) – this last one a UEFA Approved Stadium.

13. RECIPNEU supplies of cryogenic rubber granulates for rubber infills have the following main caractheristics:

- Product aspect: black rubber granulate, dry, uniform, free flowing, odour free, black dust free, steel and textile free;
- Standard nominal sizes: [0.6 – 1.4 mm], [1 – 2 mm], and [1 – 2.4 mm];
- Packaging: big-bags of 1.2 ton, nylon double strapped over wooden pallet;
- Transportation loads: in a truck, we can load 18 – 22 big-bags (depending upon vehicle weight and length, and national legislations on maximum weight loads); in a 20 feet container, we can load 10 big-bags; in a 40 feet container, we can load 20 big-bags.

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Vasco Pampulim
RECIPNEU
www.recipneu.com
v.pampulim@recipneu.com
vasco.pampulim@gmail.com
Tel.: +351 269 878 213
Fax: +351 269 878 172