# PILOT FLAKE PRODUCTION

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## Introduction

Industrial scale production of buoyant flakes will require a substantial plant. This would be hard to justify for experimental and pilot purposes. A much less capital-intensive method of flake production is needed. Fortunately, a design for this is available. It uses a slightly different process, but one that can readily be built, tested and refined fairly cheaply and quickly, and mainly from off-the-shelf components. Its capacity should be great enough for the early pilot runs and it may be replicated easily enough to provide greater capacity.

## Process Design

A thin, aqueous glue is made by boiling and macerating one of the poorer grades of rice in water. Such a grade might comprise spoiled or broken grains, possibly combined with finely-sieved high-silica, rice mill dust. Into this glue is mixed lignin powder of a quality that is both thermoplastic and insoluble in seawater, together with a small proportion of powdered ammonium bicarbonate (NH4HCO3) to act as a leavening agent. Typically, the lignin powder will be produced as a by-product from straw from which the cellulose component has been separated from the lignin and hemicellulose components by enzymatic hydrolysis, organosolv, or subcritical water processes. This is followed by the precipitation of the lignin powder using aqueous, or aqueous non-contaminating carbon dioxide (CO2) under pressure (carbonic acid), as the precipitating and recoverable agent. The lignin powder may best be recovered after its precipitation using froth flotation with microbubbles produced by fluidic oscillators, or by other means. Should the lignin recovery process be conducted on-site or nearby, there is no need for it to be dried or bagged.

The resulting glue mixture is micronized to a fine mist by spraying it under high pressure through fine nozzles, similar to the way that heavy oil is treated when fired in boilers. Into this mist are introduced well-separated, dry rice husks. As these become moistened, their density becomes greater and they sink faster. At a level where the husks are thoroughly coated in the glue-lignin mix, a mixture of low-grade and waste mineral powders rich in a carefully-formulated mixture of phosphate, silica, iron and an assortment of lesser phytoplanktonic nutrients is projected into the stream of damp, falling rice husks. The minerals attach themselves to the glue, thoroughly coating the husks. These, together with unattached particles of glue and mineral dust, fall onto a conveyor belt covered with a double layer of dry rice husks (in order to keep the belt relatively free of encrustation). More, dry husks are added to the top of the ‘sandwich’ for a similar anti-encrustation purpose. The sandwich of materials on the conveyor belt is compressed between heated rollers, flattening it and removing most of the moisture from the glue. The sandwich is then broken up into flake-sized pieces, unattached fine material being then sieved off and recycled. The lighter husks that are not well-coated in heavy lignin, glue and minerals are pneumatically removed and recycled, leaving behind only well-coated flakes. These are then cooked on a metal-mesh conveyor belt by passing it through an oven or under infra-red lamps. The cooking process causes the leavening to form tiny gas vacuoles inside each flake. The process then removes the remaining moisture and softens the lignin powder particles in the glue, such that they both link up to their neighbours and bond themselves thermoplasticly to both husk and minerals. The matrix tends to contract under this treatment, whilst retaining its basically cellular form. The temperature of the cooking process may be such that a degree of carbonisation is made to occur in the flake to ensure that dried rice glue will not unduly weaken the flake structure during long ocean immersion. A degree of carbonisation would also tend to prevent metabolic destruction of the carbonaceous material, thereby leading to its long-term biosequestration in the ocean sediments of even warm seas. The ammonia, steam and CO2 released from the degradation (at >360C) of the ammonium bicarbonate in the cooking process may be recovered and used to form more ammonium bicarbonate when the process goes to full industrial scale. Thus, nothing would be wasted. In the absence of an enclosed system, adequate exhaust ventilation or the use of respirators and protective clothing is required when using ammonium bicarbonate, as both it and its degradation product, ammonia, are irritants.

If found desirable, flakes may be similarly re-coated more times in order to build up their gas vacuole porosity and their mineral and lignin content. Re-coating may occur either after each cooking stage, or else prior to the sole cooking stage. The porosity would be designed to produce a closed, rather than an open, cellular structure, thereby minimising subsequent seawater intrusion by capillary action and ensuring long-term flake buoyancy and structural integrity.