CLAIMS

1. An apparatus for producing a flowable slush (2) of frozen particles, including:

a cooling means (11) for partially freezing a liquid (1) to form the flowable slush;

a tank (22) for storing the flowable slush;

a powered agitator (23) for agitating the flowable slush within the tank;

a separator (35) for separating a portion of the liquid remaining in the flowable slush stored in the tank from the frozen particles in a separation phase (63) of a treatment cycle;

a comminution means (40) for comminuting the frozen particles in the flowable slush stored in the tank in a comminution phase (62) of the treatment cycle; and

a control system (100) for controlling the treatment cycle;

wherein the control system includes means for sensing at least one operating parameter (OP) of the agitator (23); and characterized in that

the control system is configured:

- to monitor a control parameter (CP), wherein the control parameter is based on at least the sensed operating parameter (OP) of the agitator, and

- to initiate the treatment cycle responsive at least to the control parameter reaching a threshold value (CPt); wherein

the sensed operating parameter (OP) of the agitator represents a power input to the agitator, and

the control parameter (CP) represents a cumulative energy input to the flowable slush (2) stored in the tank (22) over a reference time period; and

the control parameter is based on at least the sensed operating parameter of the agitator over the reference time period.

2. An apparatus according to claim 1, wherein:

the control system (100) further includes first (27) and second (28) temperature sensors arranged to sense respectively a first temperature (T1) of the liquid or flowable slush and an ambient temperature (T2) external to the tank; and

the control parameter (CP) is based on at least the sensed operating parameter (OP) of the agitator (23) over the reference time period and a temperature differential (ΔT) between the first and ambient temperatures.

3. An apparatus according to any of claim 1 or claim 2, wherein the control system is arranged to initiate the treatment cycle with the comminution phase (62).

4. An apparatus according to claim 3, wherein the control system is arranged to initiate the separation phase (63) following the comminution phase (62),
and to terminate the separation phase responsive at least to a sensed rheometric parameter (RP) of the flowable slush (2) reaching a threshold value (RPt).

5. An apparatus according to claim 4, including at least one slush pump (31) for circulating the flowable slush stored in the tank via each of the separator (35) and the comminution means (40) and back to the tank (22) in the treatment cycle; and wherein
a rheometric sensing means (42) is arranged in a flowpath of the flowable slush to sense the rheometric parameter of the flowable slush circulating through the flowpath during the treatment cycle.

6. An apparatus according to claim 5, wherein the rheometric parameter (RP) is a pressure of the flowable slush in the flowpath.

7. An apparatus according to claim 6, wherein a separated liquid valve (38) is arranged to control a flow of said portion of the liquid (1) from the separator (35),
and the control system is arranged to close the separated liquid valve periodically during the treatment cycle and to sense the pressure while the separated liquid valve is closed.

8. A method for producing a flowable slush (2) of frozen particles, including:
partially freezing a liquid (1) to form the flowable slush;

storing the flowable slush in a tank (22);

supplying power to an agitator (23) to agitate the flowable slush within the tank; and

treating the flowable slush stored in the tank during a treatment cycle, including:

comminuting the frozen particles in the flowable slush stored in the tank during a comminution phase (62) of the treatment cycle, and

separating a portion of the liquid remaining in the flowable slush stored in the tank from the frozen particles in a separation phase (63) of the treatment cycle; wherein the method further includes:

sensing at least one operating parameter (OP) of the agitator,

monitoring a control parameter (CP), wherein the control parameter is based on at least the sensed operating parameter of the agitator, and

initiating the treatment cycle responsive at least to the control parameter reaching a threshold value (CPt); and wherein

the sensed operating parameter (OP) of the agitator represents the power supplied to the agitator, and

the control parameter (CP) represents a cumulative energy input to the flowable slush stored in the tank over a reference time period. and

the control parameter is based on at least the sensed operating parameter of the agitator over the reference time period.

9. A method according to claim 8, including:

sensing a first temperature (T1) of the liquid or flowable slush and an ambient temperature (T2) external to the tank; wherein

the control parameter (CP) is based on at least the sensed operating parameter (OP) of the agitator over the reference time period and a temperature differential (ΔT) between the first and ambient temperatures.

10. A method according to any of claim–8 or claim 9, wherein the treatment cycle is initiated with the comminution phase (62).

11. A method according to claim 10, including:

sensing a rheometric parameter (RP) of the flowable slush,

initiating the separation phase (63) following the comminution phase (62), and

terminating the separation phase responsive at least to the sensed rheometric parameter reaching a threshold value (RPt).

12. A method according to claim 11, including:

circulating the flowable slush stored in the tank via each of a separator (35) and a comminution means (40) and back to the tank in the treatment cycle; and

sensing the rheometric parameter (RP) of the flowable slush circulating through a flowpath during the treatment cycle.

13. A method according to claim 12, wherein the rheometric parameter (RP) is sensed as a pressure of the flowable slush in the flowpath.