# Summary

**Background** Biscuit handling between oven and packaging is comprised of many sections and operations, chief among which are transport and buffering. Two common methods for achieving transport and buffering in the same transport line are the use of belt transporters and vibratory transporters. Both modes have positive and negative aspects. Though vibratory transport is generally preferable for biscuit transport, the noise and possible product damage caused by repeated impact of biscuit and transport surface are of major concern. Houdijk Holland BV has expressed an interest in a vibratory conveyor with no vertical displacement (Horizontal oscillation) to so avoid the separation of biscuit and surface and resultant impact. A study of the mechanisms of vibratory transport, with and without vertical component, and its applicability to biscuit transport and buffering is reported here.

**Results** Transport using a horizontally oscillating surface is a specific version of vibratory transport. The vibratory transporter currently built by Houdijk Holland vibrates the transport surface at high frequency and small amplitude at an angle to the transport direction, this results in a hopping characteristic for the forward movement of the transport mass (biscuits) with resultant impact at every landing. The sinusoidal movement of the transport surface becomes less effective at transport as the Throw Number decreases. To achieve effective transport with purely horizontal oscillation the sinusoidal motion must be replaced with differential motion, a difference must exist between the forward and reverse stroke. As long as the accelerations are such that relative slip between surface and biscuit can be induced it is possible to achieve net transport. Stick-slip theory indicates that useful transport speeds can be achieved with acceptable frequencies and amplitudes for commercial biscuit production. Quantitative results show that these speeds are attainable and that the biscuit behavior in the transport trough allows for buffering on the transport line. The driving motion resulting in stick-slip can be optimized for higher speeds at the cost of increased amplitude and inertial forces. The coulomb Pump theory indicates that similar results can be achieved without a sticking phase (forward slip & reverse slip) though this results in even greater amplitude.

**Conclusions** The theoretical study of horizontal differential motion, in conjunction with experimental results, indicates that a reciprocating conveyor is a viable option for biscuit transport and buffering. The lack of vertical component and resultant impact dramatically reduces the noise and product damage when compared to current vibratory methods. Inter-product pressure remains sufficient for thrust but bellow detrimental levels experienced by long belt transporters allowing for handling of fragile products which cannot be buffered with current vibratory or long belt transporters.