This thesis focused on identification of the fouling components in sugarcane juice UF, particularly in the feed polysaccharide fraction, followed by fouling control through surface modification of polysulfone (PS) / polyethersulfone (PES) membranes. Commercial PS and PES membranes, having nominal MWCO ratings between 10 and 150 kD, were tested with sugarcane juice as well as the juice polysaccharide fraction, which was used as a model foulant. A detailed characterization of the foulant was performed, and the effect of fouling was monitored through water flux reduction and changes in the membrane cutoff and pore size distribution. Different chemical cleaning procedures, with emphasis on short cleaning duration (< 30 minutes), were examined. Select membranes were modified via photograft copolymerization using poly(ethyleneglycol) monomethacrylate (PEGMA) monomer and their UF performance with sugarcane juice was investigated.

The main conclusions of this work are summarized below.

- Membrane fouling in sugarcane juice UF is predominantly due to the dissolved non-sugar components. Clarified juice obtained by either conventional liming or the liming-sulfitation process is therefore better suited for UF compared to the untreated mixed juice.
- Surface fouling is an important phenomenon in this application. Rapid pore blocking / narrowing appears to occur in the early stages of UF and cake fouling dominates thereafter.
- The polysaccharide fraction in sugarcane juice is a significant membrane foulant. This fraction primarily has two components viz. a 130 kD high molecular weight (HMW) component and a 10 kD low molecular weight component. The HMW component containing arabinogalactan protein, along with some phenolics and lipids, appears to be primarily responsible for fouling. This component is not completely precipitated by the conventional juice clarification process. Therefore even though the protein content in sugarcane juice is very small, it has a significant impact on membrane fouling.
• Short chemical cleaning cycles (up to 20 minutes) with a combination of up to 2 % w/v NaOH and up to 200 ppm NaOCl is effective for both water and juice flux recovery. However, NaOCl exposure, even for a short duration (up to 10 minutes), leads to significant change in membrane properties, including flux enhancement and even pore damage.

• Repeated UF-cleaning operations need not necessarily result in progressively low product flux. Modification in membrane properties (pore enlargement, increased hydrophilicity) can actually result in flux improvement over successive UF-cleaning cycles.

• Membranes with low water flux (< 150 L/m²h) foul less and are more amenable to chemical cleaning after being fouled with the polysaccharide fraction. In view of this observation and the presence of a 130kD component in the polysaccharide fraction, membranes with a NMWCO rating between 30-50 kD appear to be most appropriate for this application.

• Membrane surface modification is capable of reducing the extent of fouling with both polysaccharides & sugarcane juice. It decreases the membrane propensity to foul; furthermore, the membrane-foulant interaction is weak making cleaning easier. These advantages are obtained even at low degree of grafting (26-36 μg/cm²). Of the membranes evaluated, the modified UF-PS-100H membrane was the best for this application.

• The benefits of modification tend to be more pronounced with the model foulant (juice polysaccharide fraction). The presence of other solutes in the feed dilutes this effect. This aspect should be borne in mind in applications with multi-component feed streams, especially since performance evaluations are initially conducted with model solutes.

The following aspects are recommended for subsequent investigations.

• The juice polysaccharide fraction should be completely characterized, particularly in terms of its monomer composition. Further, the 10 kD component should also be isolated and characterized. These would contribute towards understanding the characteristics and composition of the fouling deposits.
The membrane cleaning protocol and its effect on membrane characteristics needs further investigation. In particular, the effect of hypochlorite on fouled membrane properties like hydrophilicity, zeta-potential etc. should be systematically examined; further, the extent of cleaning should be monitored using FTIR and EDX SEM. In particular, the alteration in membrane properties over successive UF-cleaning cycles should be examined. In addition, the effect of alternative cleaners (specific enzymes, detergents) may be explored.

The modification protocol employed in this work resulted in a relatively low degree of grafting and thus the fouling reduction was not as significant as expected. Thus, this protocol could be modified to obtain a high degree of grafting; also, other appropriate monomers (which are known to reduce polysaccharide / protein fouling) can be examined.

In contrast to extensive investigations on protein fouling, there are limited studies on membrane fouling by polysaccharides and their subsequent cleaning. Considering that polysaccharides are present in most complex feed streams (e.g. juices, beverages, water, wastewater) which are subjected to MF/UF treatment, fundamental studies on model polysaccharides as well as protein/polysaccharide mixtures to understand their filtration behavior is required.

Further testing on the modified membranes should be conducted, especially to evaluate their long-term performance and flux recovery after cleaning. This will eventually enable a cost comparison between the modified and the unmodified membranes, and their contribution to the final product (sugar) quality.