# CHEMICAL ECONOMICS - PLASTIC BAGS

Presently there is renewed interest in banning or taxing plastic bags used in supermarkets. The aim is to try to reduce perceived problems with plastic bag litter. Supermarket chains import these bags by the billion and I am not aware of any production in Australia.

When I first came to Australia in the early 1980s, supermarkets used paper bags. There was a bagger (usually a spotty youth) employed on each payment aisle to assist the customer and speed up throughput. Plastic bags are considerably cheaper than paper bags, and along with the metal holding rack, allowed the cashier to do the bagging hence eliminating the bagger.

Plastic bags first came to be an item of use in the 1950s when low density polyethylene (LDPE) became available. LDPE is the original form of polyethylene, accidently discovered in the 1930s when trying to convert ethylene into lubricating oil at high pressure (2,000 atmospheres). In the present day technology ethylene and free radical initiators polymerise ethylene at 200 atm.

LDPE chains have a high level of branching. Many of the branches areC2 and C4 units caused by a primary radical back-biting the growing chain. There are also longer branches, also with pendent C4 groups, and some long range cross-linking. Bags made from LDPE are very strong and find use for carrying heavy material such as fertilizer; they are often reused by builders merchants selling sand.

In the early 1950s, organo-metallic catalysts for ethylene polymerisation at low pressure were discovered and developed by Ziegler and by workers at Phillips Petroleum. The product has little if any branching and the chains can be closely packed producing high density polyethylene (HDPE). HDPE is cheap to produce and is usually used for bottles etc. Bags made from HDPE are generally weak.

In the 1960s, the idea was developed that co-polymers made by the low pressure route of ethylene, butene and hexene could have similar properties to LDPE. Such copolymers where produced in which butene/hexene was incorporated randomly into a growing ethylene chain and thus had randomly distributed pendent C2/ C4 groups. The density was intermediate between LDPE and HDPE and was named linear low-density polyethylene (LLDPE). Bags made by this route were found to be durable (sometimes better than LDPE) and relative cheap to produce.

My first industrial R&D job (40 years ago) was on the periphery of a project to develop a new and cheaper way to make LLDPE.

Organo-metallic chemistry was all the rage in the late 1960 and early 1970s and the company was researching novel organo-metallic catalysts for polymerisation. A new system was invented which appeared to deliver LLDPE cheaper than the routes in use at the time. A large research program was launched which involved three separate divisions of the company - central research, the monomer division and the polymer division.

Furthermore, if the catalyst could randomly co-polymerise monomers, then co-polymerisation of ethylene, propylene and a diene could lead to EPDM elastomer (rubber). This could lead to a new rubber division for the company and more resources where placed at the disposal of the project.

This was a time of general downturn in the chemical industry and researchers not involved looked jealously on as more resources were poured into the effort.

One chemist on the project realising that resources where unlimited, took the opportunity to research the best solvent for cleaning old paint brushes. He found the best to be ethanolamine.

Because of the complexity of the project and the need for good communications it was decided to have a monthly conference at some central location with easy access from the various research groups. A suitable conference facility was identified which also just happened to have a fine dining restaurant, wine cellar and overnight accommodation.

At an early co-ordination meeting, the audience was enraptured by a physicist who described testing procedures for the films being produced. This involved dropping a dart on the film and measuring, in exacting detail, the shape of the deformation which was duly mathematically modelled proving the high quality of the LLDPE produced.

A chemist working in the analytical laboratory related how he had examined the products by infra-red spectrometry. He said he thought there was some problems with the LLDPE (long runs of homo-polymer in the chains) and the EPDM did not look much like rubber. Defeatist of this ilk were not welcome and he was not invited to further meetings.

After dinner, duck a L'orange with fine Burgundy, as the port was served with Stilton, the benefits of ethanolamine solvent was discussed.

The project got bigger with a large technical plant for producing the LLDPE and a bagging line to produce bags. A demonstration of the product was organised and the company directors invited to witness.

Back then it was common for fertilizer bags to be unloaded from trucks by manually throwing them off. LDPE was durable enough for this treatment. At the demonstration, fertilizer bagged in the new LLDPE was placed on the back of a truck along with two likely lads to do the throwing.

The assembled crowd with the directors in front, all in fine suits, gathered around the truck tail-gate and the first bag was off-loaded. On striking the ground the bag split and sprayed fertilizer over the witnesses. The directors dusted themselves off and took a step back. Perhaps the first was just a one-off, so a second was off-loaded with the same result and again with a third.

The directors, dusted themselves off again and left. The silent crowd slowly dispersed. Only the two likely lads seemed to be amused by the event.

In private enterprise thinks can happen quite quickly. All the reports were re-classified as ultra secret only to be accessed with written permission of a director. The demonstration was on Friday, weekends away were cancelled and at 9am on Monday the project was canned.

Scientist were re-assigned to managers not involved with the project who now with larger groups were promoted. The inventor sent back to the lab (he later had a career as an academic), the analyst sent back and was never promoted. No-one knows what happened to the physicist. The chemist went on to discover other uses for ethanolamine.

And so this was my first experience of the cycle for major projects: unquestioning enthusiasm, disillusionment, panic and hysteria, the hunt for the guilty, punishment of the innocent and reward for the uninvolved. It was not the last.

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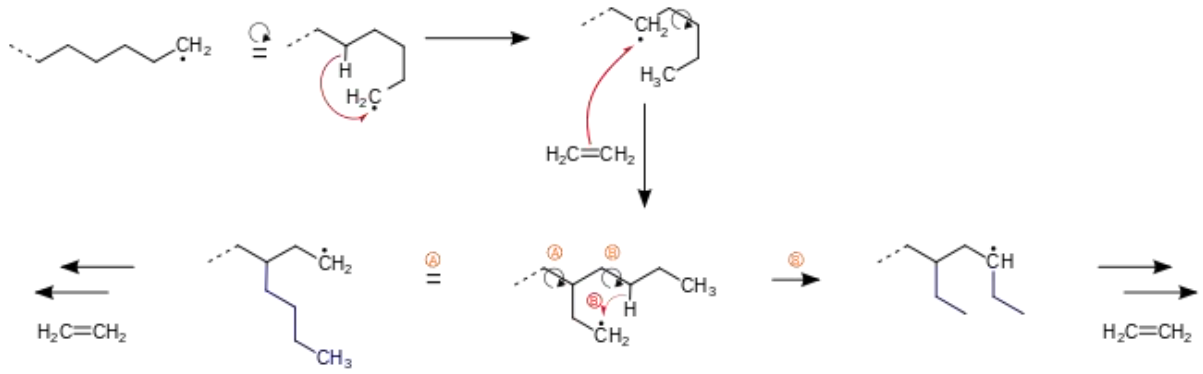
I got this from Wikipedia, might be useful as a graphic: By Minihaa - Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=46272338




B: Formation of butyl side chain

A: Formation of ethyl side chains (adjacent)

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The conference centre: