

Gas Flush Product Development

1 Abstract

The raw meat packaging industry commonly uses Linear Low-Density Polyethylene (LLDPE) because it provides an appealing bright red appearance. However, its relatively high oxygen permeability can lead to faster color fading and reduced product freshness. In this study, High-Density Polyethylene (HDPE) was blended with LLDPE and compared with HDPE/LLDPE co-extruded films to improve barrier performance. The influence of HDPE placement in different co-extrusion layers was also examined, based on Fick's law of diffusion and Henry's law of gas solubility. All experiments were conducted following the ASTM D3985 standard for oxygen transmission rate (OTR) measurements under consistent pressure and temperature and 0% humidity conditions.

2 Ideal application

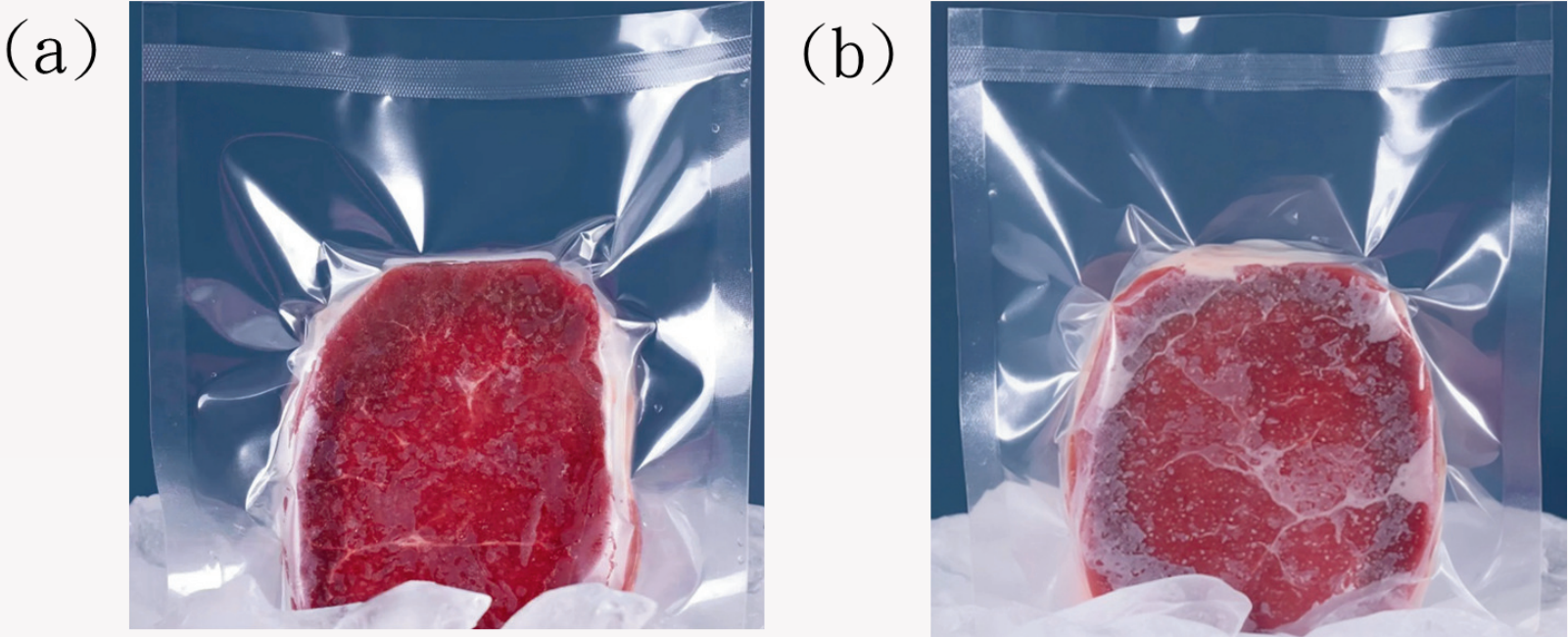


Figure 1. Raw meat in (a) high-oxygen-barrier and (b) low-oxygen-barrier packages after three days of delivery. Sample (a) shows a bright red appearance.

3 Product process

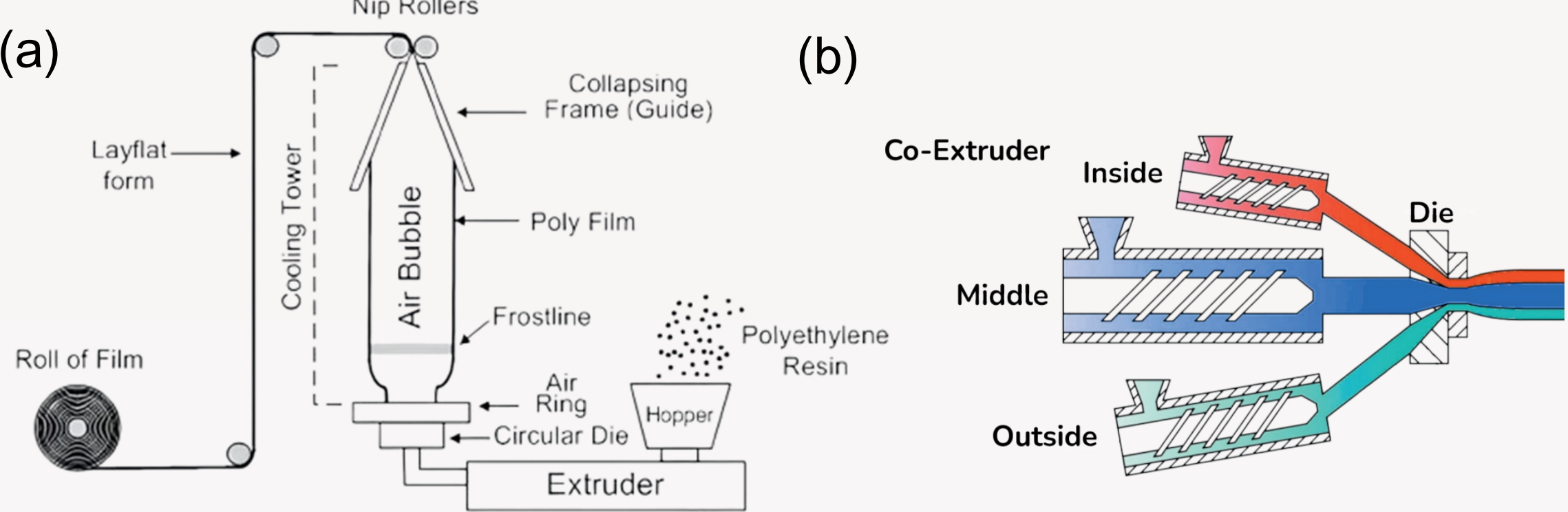


Figure 2. Packaging films produced by (b) co-extrusion and single-extrusion processes using the (a) blown film process.

4 Gas permeation theory

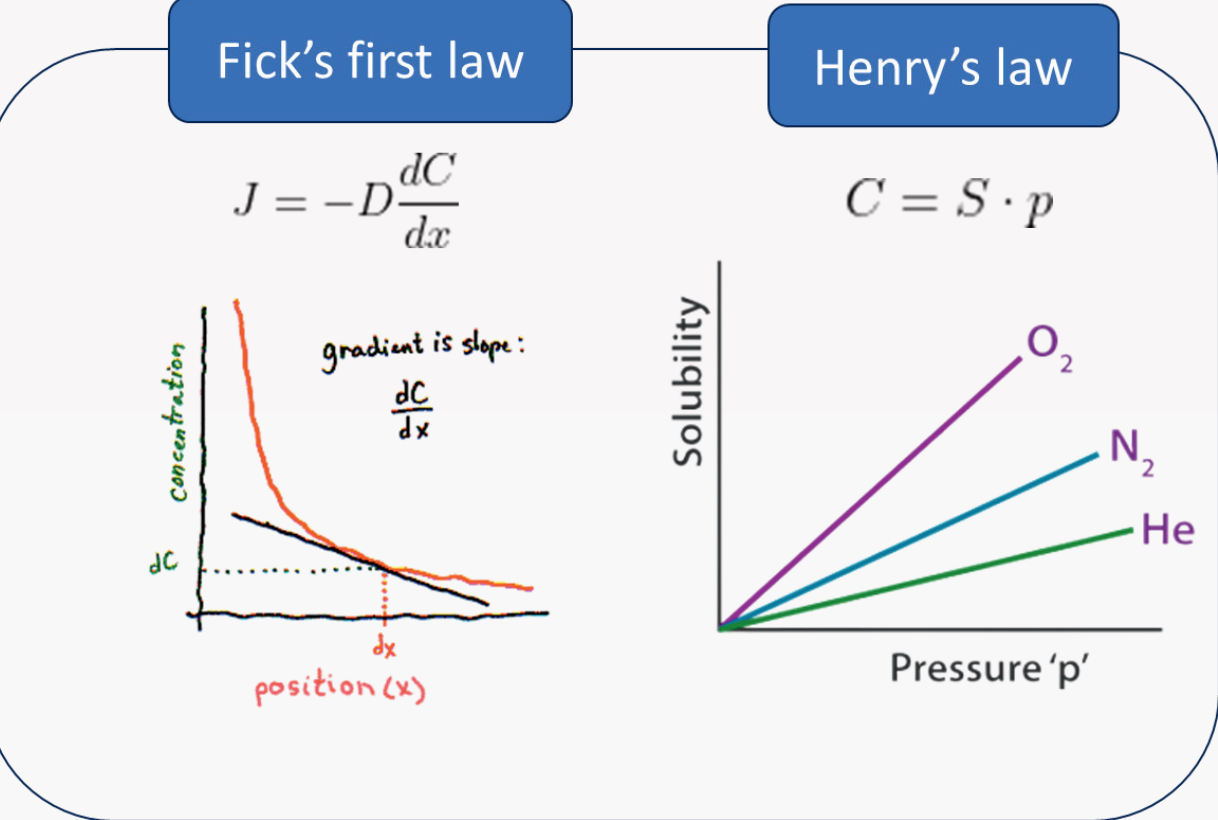


Figure 3. Gas permeation through the film depends on both the rate of molecular diffusion (governed by Fick's law) and the extent of gas absorption at the surface (governed by Henry's law).

5 Factors affecting OTR value

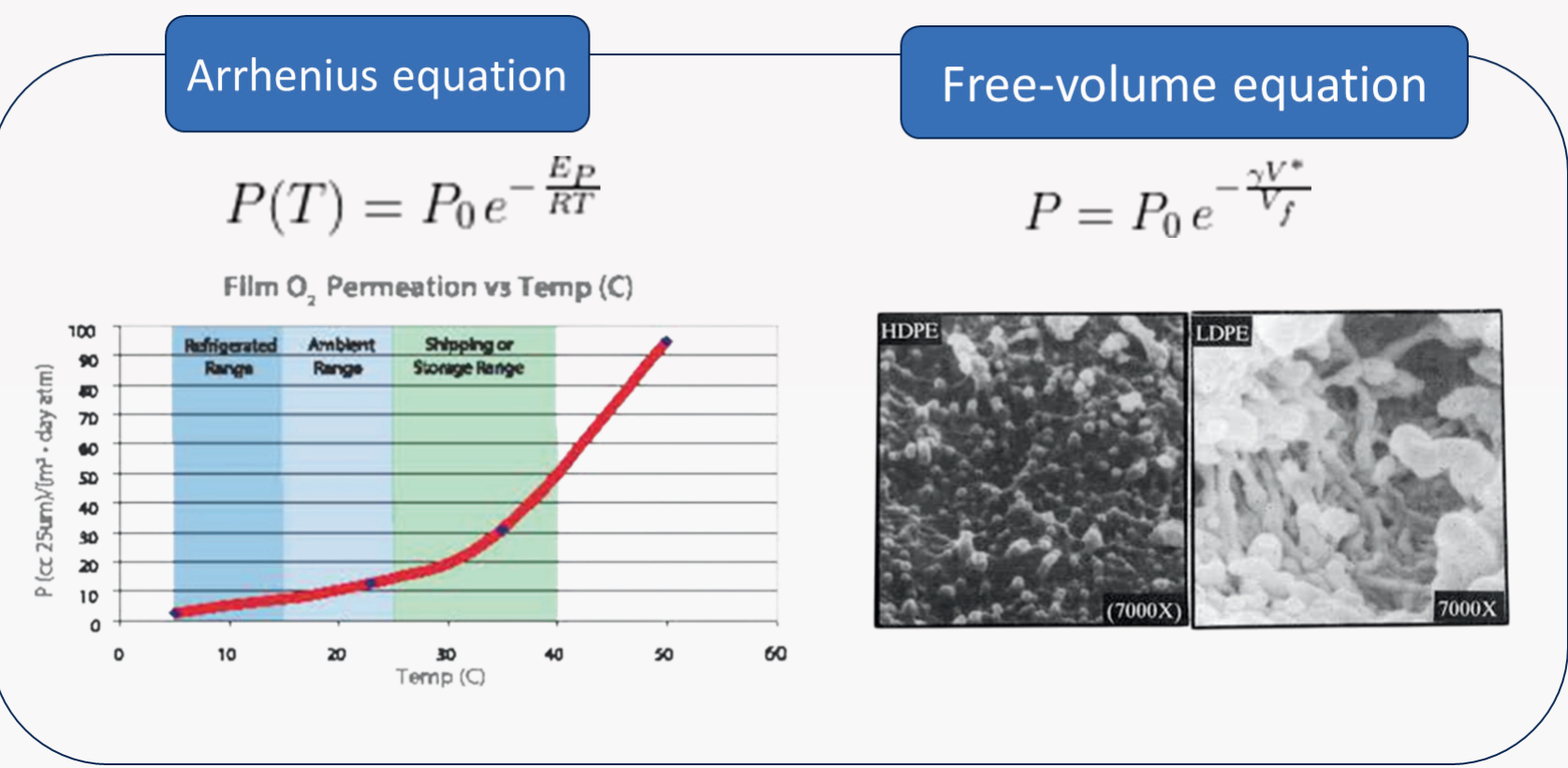


Figure 4. Gas permeation increases exponentially with temperature, following the Arrhenius relationship. Higher crystallinity reduces gas permeability according to the free volume theory.

6 ASTM D3985

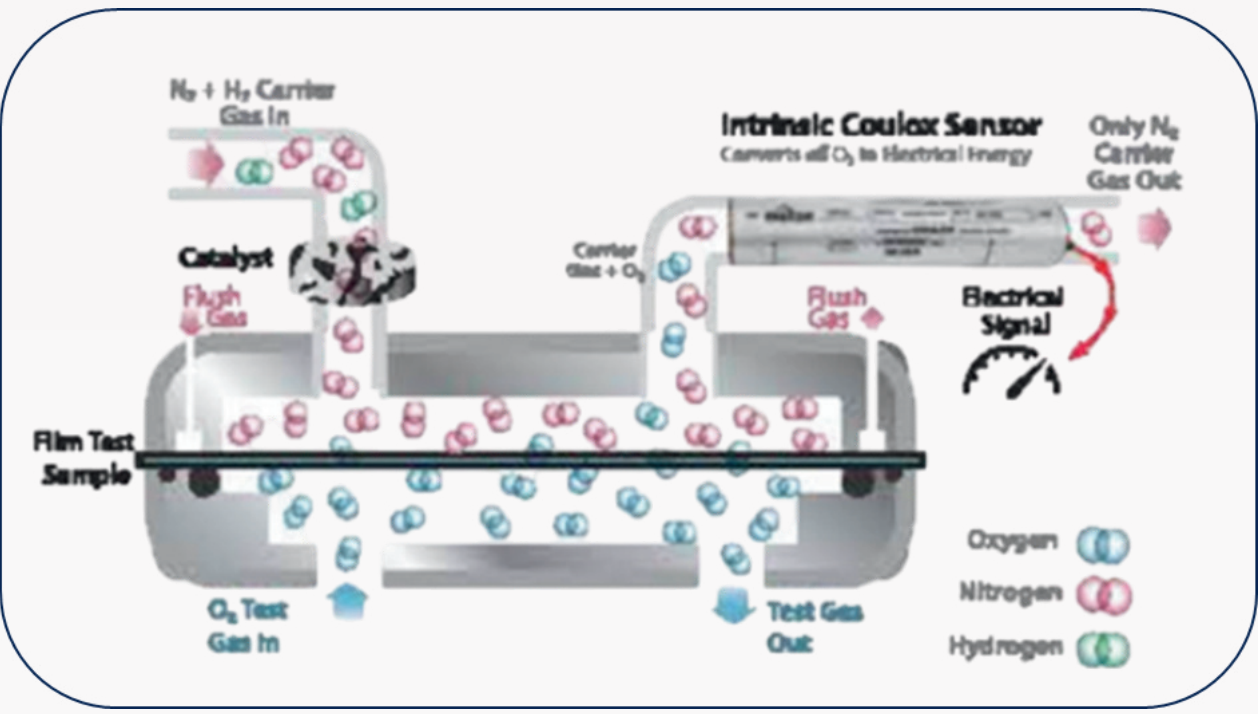


Figure 5. Schematic of the ASTM D3985 test setup. Oxygen is introduced on the downstream side, while He/H₂ carriers gas mixture flow on the upstream side to measure the oxygen transmission rate (OTR).

6 Formulation Design

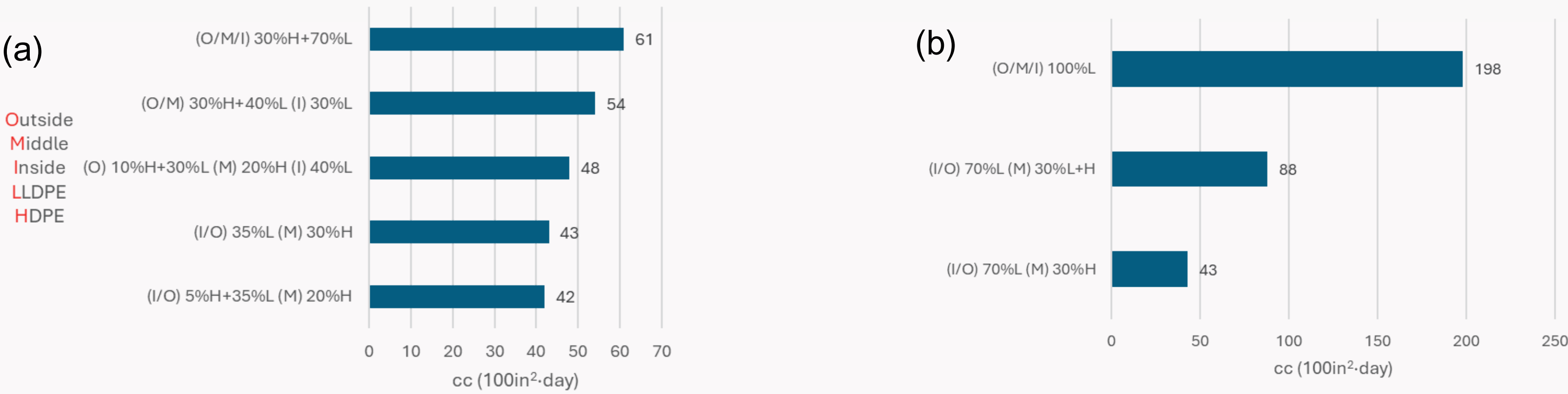


Chart (a) Each formulation comprises 30% high-barrier (H) and 70% low-barrier (L) components. The chart compares the effects of varying HDPE concentrations and placements in different co-extrusion layers. Chart (b). The chart presents a comparison of OTR for films produced using single-extrusion and co-extrusion processes. It further compares the performance of H/L blended films with that of co-extruded H/L multilayer films to illustrate the influence of processing method and film structure on oxygen barrier properties.

7 Conclusion

1. Co-extrusion offers greater flexibility and higher barrier performance during film fabrication.
2. The addition of 10% HDPE to both the surface and inner layers significantly reduces oxygen transmission rate (OTR), improving the overall barrier properties of the film.