



***REXtac APAO Heptane  
Solubles***

# *REXtac APAO Heptane Solubles*

- The Heptane Soluble (H.S.) fraction of a polymer measures:
  - the amount of the polymer that is amorphous, or atactic, and therefore, soluble when exposed to, or extracted with, boiling heptane for several hours.
- The heptane soluble fraction is slightly dependent on the molecular weight of the polymer, but varies the most with the composition or make-up of the polymer.
- The fraction which is insoluble, or Heptane Insolubles, H.I., is typically the crystalline fraction.

# *REXtac APAO Heptane Insolubles (H.I.)*

- The heptane insoluble fraction of a polyolefin is
  - correlated to a high degree with its crystallinity
  - Crystallinity can alternatively be calculated from the heat of fusion measured by DSC (differential scanning calorimetry),
- The higher the DSC heat of fusion of a polyolefin, the higher the crystallinity, and the higher its heptane insoluble fraction.
- For example, isotactic polypropylene, iPP, has a heptane insoluble fraction of higher than 96-97%, or an H.S. fraction of less than 4%.
- H.S. + H.I. = initial, un-extracted weight of the polymer.

## *REXtac APAO Heptane Solubles, cont.*

- The following table shows for all our commercially available APAOs, the
  - heptane soluble values (H.S.)
  - Average Ring and Ball Softening Point (RBSP)
  - Average Shear Adhesion Failure Temperature (SAFT)
    - RBSP and SAFT are both indicators of the temperature resistance of APAO
- A description of the experimental method is found in the Appendix.

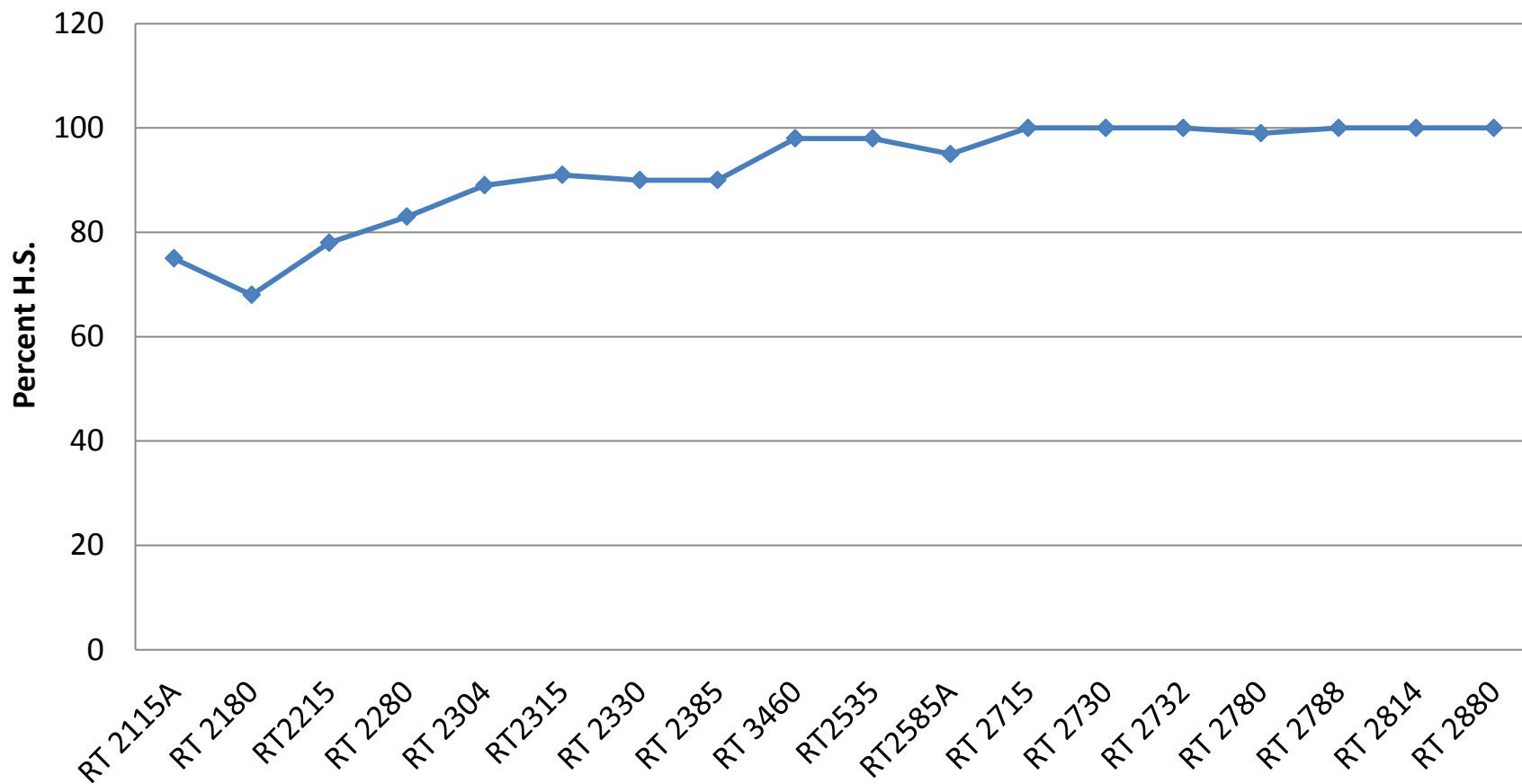
# RExtac APAO Heptane Solubles, cont.

APAO	APAO Type	Average H.S., %	Avg RBSP	Avg SAFT
RT 2115A	Homopolymer	75	313	275
RT 2180	"	68	312	270
RT2215	Low C2= copolymer	78	303	272
RT 2280	"	83	298	264
RT 2304	Medium C2= copo.	89	292	247
RT2315	"	91	289	237
RT 2330	"	90	292	244
RT 2385	"	90	292	249
RT 3460	Medium/high C2=	98	286	238
RT2535	High C2= copolymer	98	273	213
RT2585A	"	95	276	234
RT 2715	C4= copolymer	100	231	170
RT 2730	"	100	234	180
RT 2732	"	100	246	194
RT 2780	"	99	233	183
RT 2788	"	100	231	205
RT 2814	High C4= copolymer	100	180	147
RT 2880	"	100	205	179

# *REXtac APAO Heptane Solubles, cont.*

- 1<sup>st</sup> figure (on following slide):
  - shows the heptane soluble values of the different APAO, as a function of their composition
- The first few APAOs on the left side of the figure with the lowest H.S. values, correspond to:
  - homopolymers
  - low ethylene containing copolymers
- As the ethylene content increases, H.S. values increase
- For the butene-1 containing APAOs:
  - H.S. values are around 100 % indicating that these APAOs are substantially amorphous, with very little to no crystallinity.

# Fig. 1. Heptane Solubles for REXtac APAO

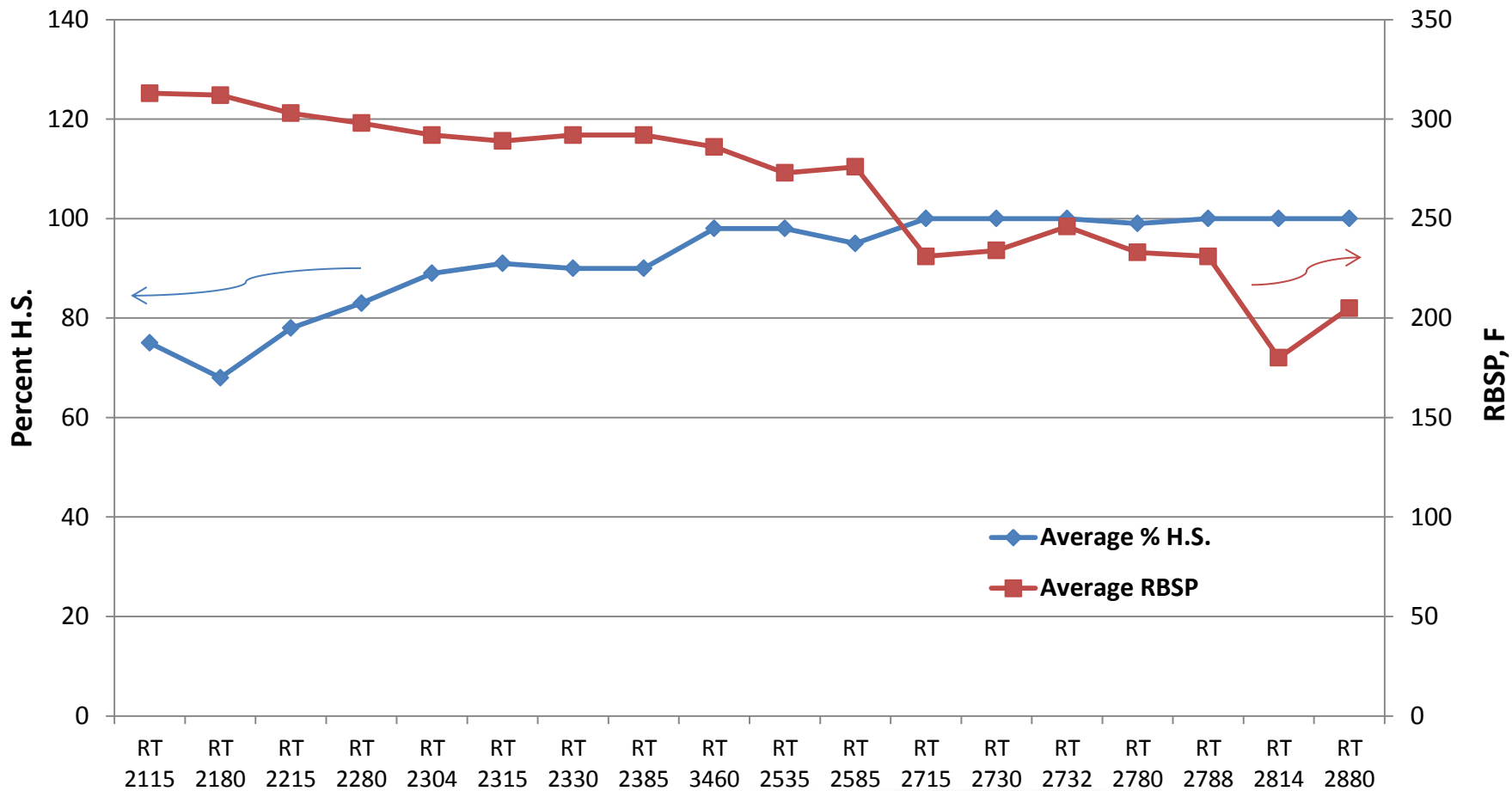


## *REXtac APAO Heptane Solubles, cont.*

- The 2<sup>nd</sup> figure shows the inverse relationship between the H.S. values, or lack of crystallinity, and the RBSP of the corresponding APAOs.
- The more crystalline APAOs (such as the homopolymers), have less H.S. and exhibit higher heat resistance as measured by the RBSP.



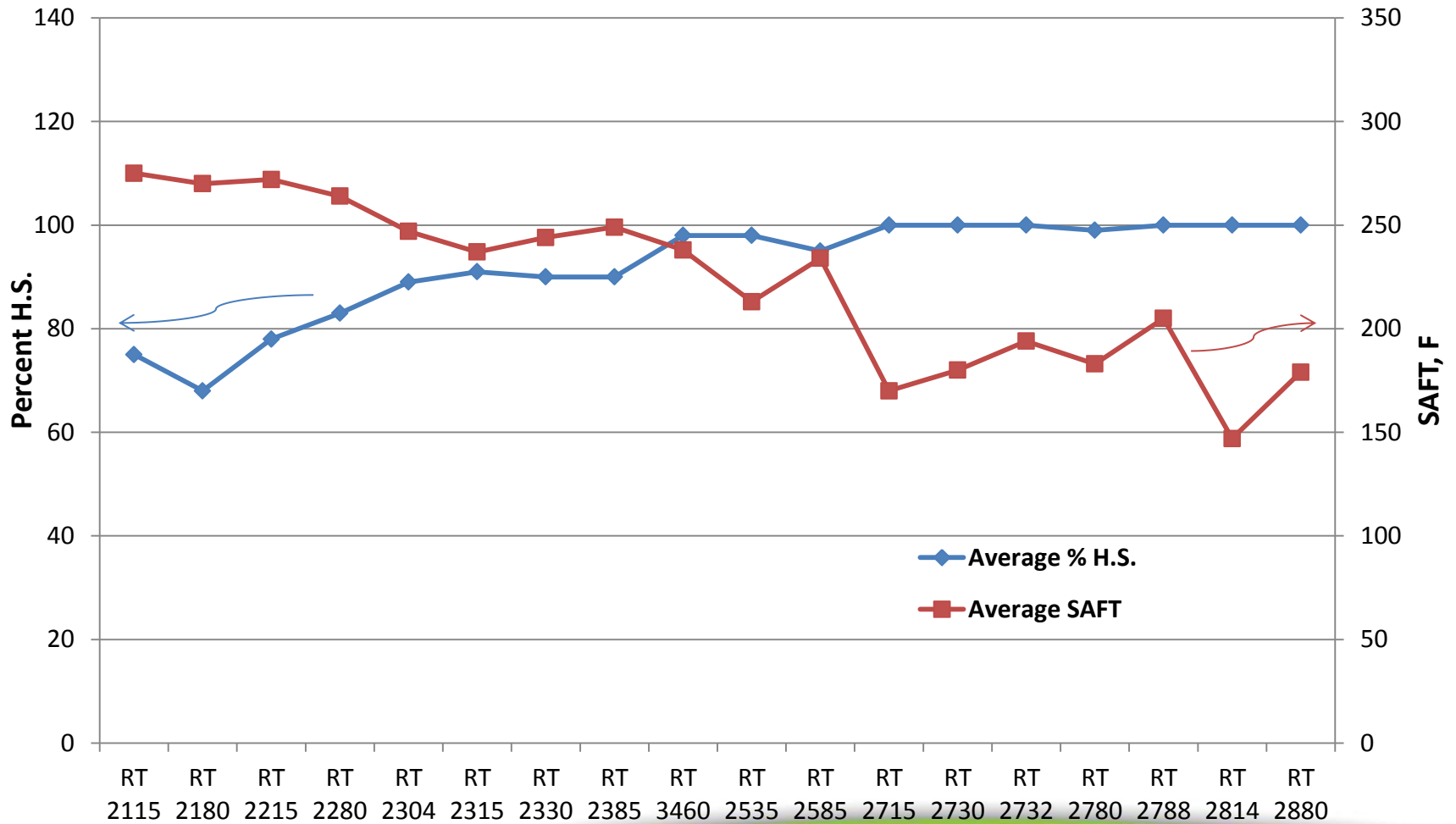
# Fig. 2. Heptane Solubles vs. RBSP for Rextac APAOs



## *REXtac APAO Heptane Solubles, cont.*

- The last figure shows the inverse relationship between the H.S. values, or lack of crystallinity, and the SAFT values of the corresponding APAOs.
- The more crystalline APAOs (such as the homopolymers), have lower H.S. values and exhibit higher heat resistance as measured by the SAFT values, just as seen for the RBSP values.

# Fig. 3. Heptane Solubles vs. SAFT for Rextac APAOs



# *REXtac APAO Heptane Solubles*

- Appendix

# *REXtac APAO Heptane Solubles, cont.,*

- **Experimental Method**

- A large glob of molten APAO at about 375 deg. F, is applied on a 2 ½ inches wide by about 5 ½ inches long 200 mesh screen, and then spread out evenly with a spatula to achieve a thick film of APAO with a weight of about 5 to 7 grams
- This laminate is allowed to cool for about 1 hr; then weighed in an analytical balance to obtain the mass of APAO sample by weight difference

# *RExtac APAO Heptane Solubles, cont.,*

- **Experimental Method, cont.**

- The laminate is formed into a roll which is then dropped into a 37 mm by 130 mm long cellulose thimble from Whatman
- The thimble and laminate are carefully placed into a Soxhlet extractor connected by flexible hoses to a chiller; then mounted on preferably a flat-bottom flask containing the heptane and a magnetic stir bar. The whole set-up rests on a hot plate.

# *RExtac APAO Heptane Solubles, cont.,*

- **Experimental Method, cont.**

- The heating plate is turned on to start the solvent extraction process, and the magnetic bar is put to spin. The bar is needed to avoid the solvent from superheating. Typically, the solvent starts to boil after about 15 minutes.
- After approximately 18 hrs, the extraction process is stopped.
- After allowing for a cool-down period of about 20 minutes, the thimble is carefully lifted out of the extractor, with a tweezer, and then allowed to dry in an oven at 120-130 deg. F overnight.

# *REXtac APAO Heptane Solubles, cont.,*

- **Experimental Method, cont.**
  - Finally, after allowing for the thimble and the extracted contents to equilibrate to standard conditions of heat and humidity in an environmentally-controlled Lab, the weight of extracted APAO is calculated by simple arithmetic.
  - All weights are obtained using a four decimal places Analytical balance
  - The determination of the APAO H.S. is done using a REXtac developed test method.