

Oxygen Pick-up

Interpreting BIB Dissolved & Total Package Oxygen Data

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Filled Package Sealing and Barrier Testing

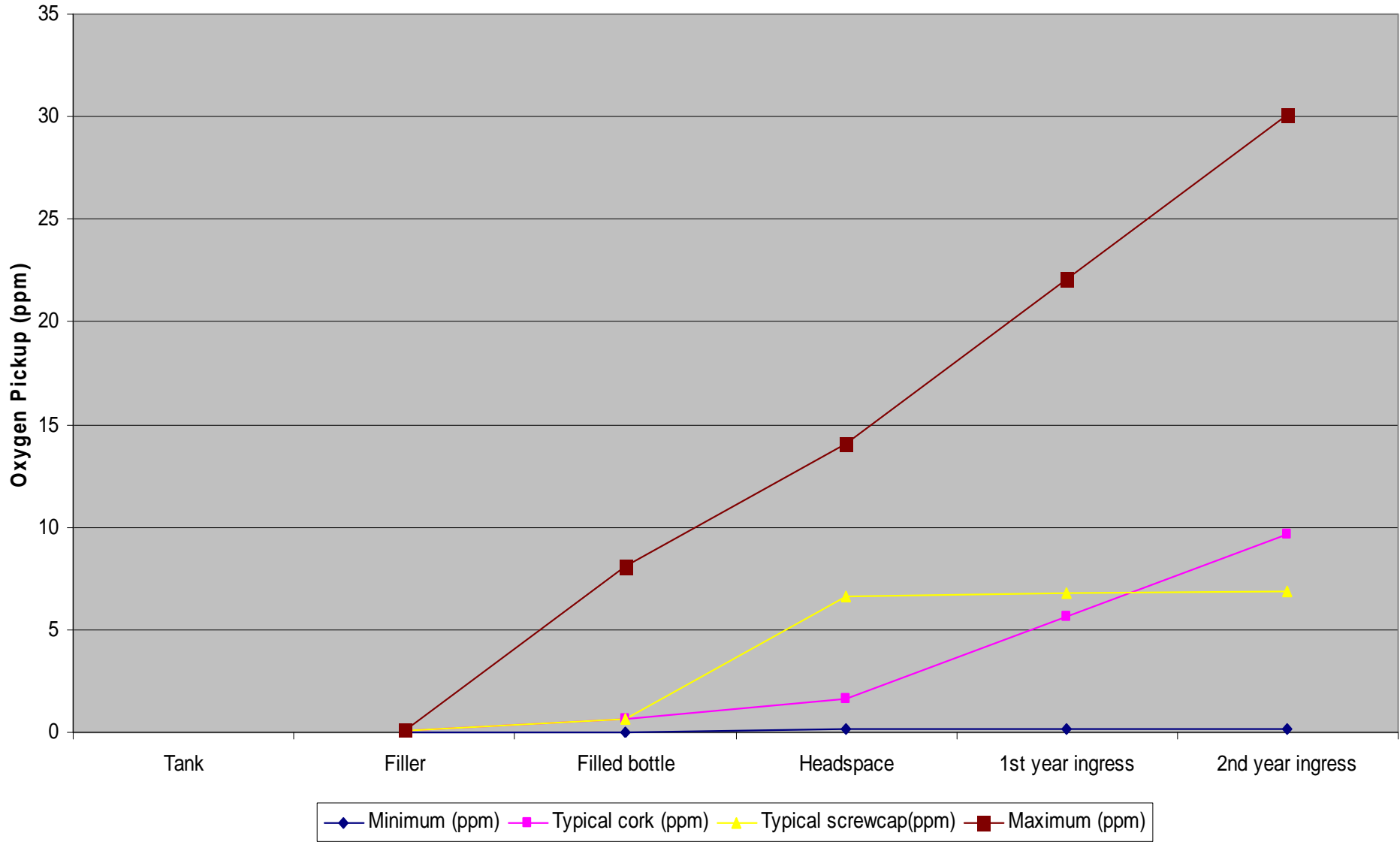
Oxygen Pick-up and Oxygen Control

- Oxygen Pick-up
 - The amount of oxygen added to the package and beverage from the filling process, the closing or sealing process and ingress through the package.
- Oxygen Control
 - The process of controlling the amount of oxygen added through the expected life of the package and product

Oxygen Pick-up

- Added during transfer & filtering
- Added in filler equipment
- Added during package filling
- Added from package headspace
- Absorbed from plastic bottle, liner & cap
- Ingress through package
- Ingress due to package failure

Oxygen Pickup vs. Process in Wine During Filling and Shelf Life (750 ml)



Bag-In-Box Oxygen Pick-up

- Mixed into wine during filling
- Additional oxygen in the headspace or cone
- Oxygen absorbed from the bag, gland, tap and air pockets within components
- Ingress through each component of the package
- Ingress through component failure
 - Gland to tap fit
 - Tap seal
 - Weld failure
 - Stress cracking

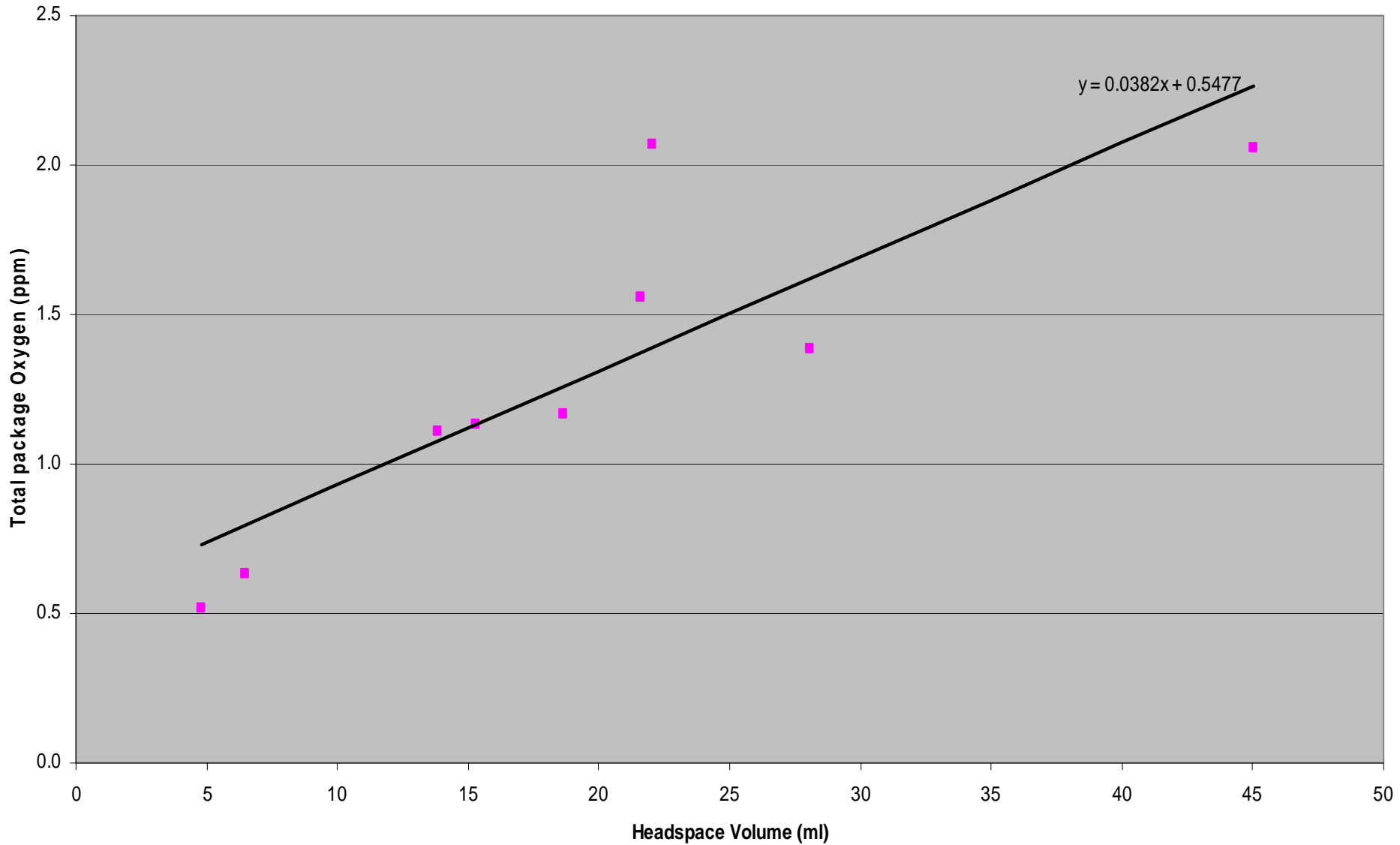
Filling

- Each filling line is different based on design, maintenance, compatibility with packaging being used
- Dissolved oxygen has to be measured immediately after filling and shaking

Headspace or Cone Oxygen

- Even with filling under vacuum or pre-purged packages the headspace can contain 20% oxygen
- The removal of the filling head and the insertion of the tap both add air to the package
- Headspace and under tap flushing with inert gas would minimize this
- Package design changes could also minimize the headspace
- In a 3 liter bag each ml of headspace air adds 0.038 mg/liter of oxygen to the wine.

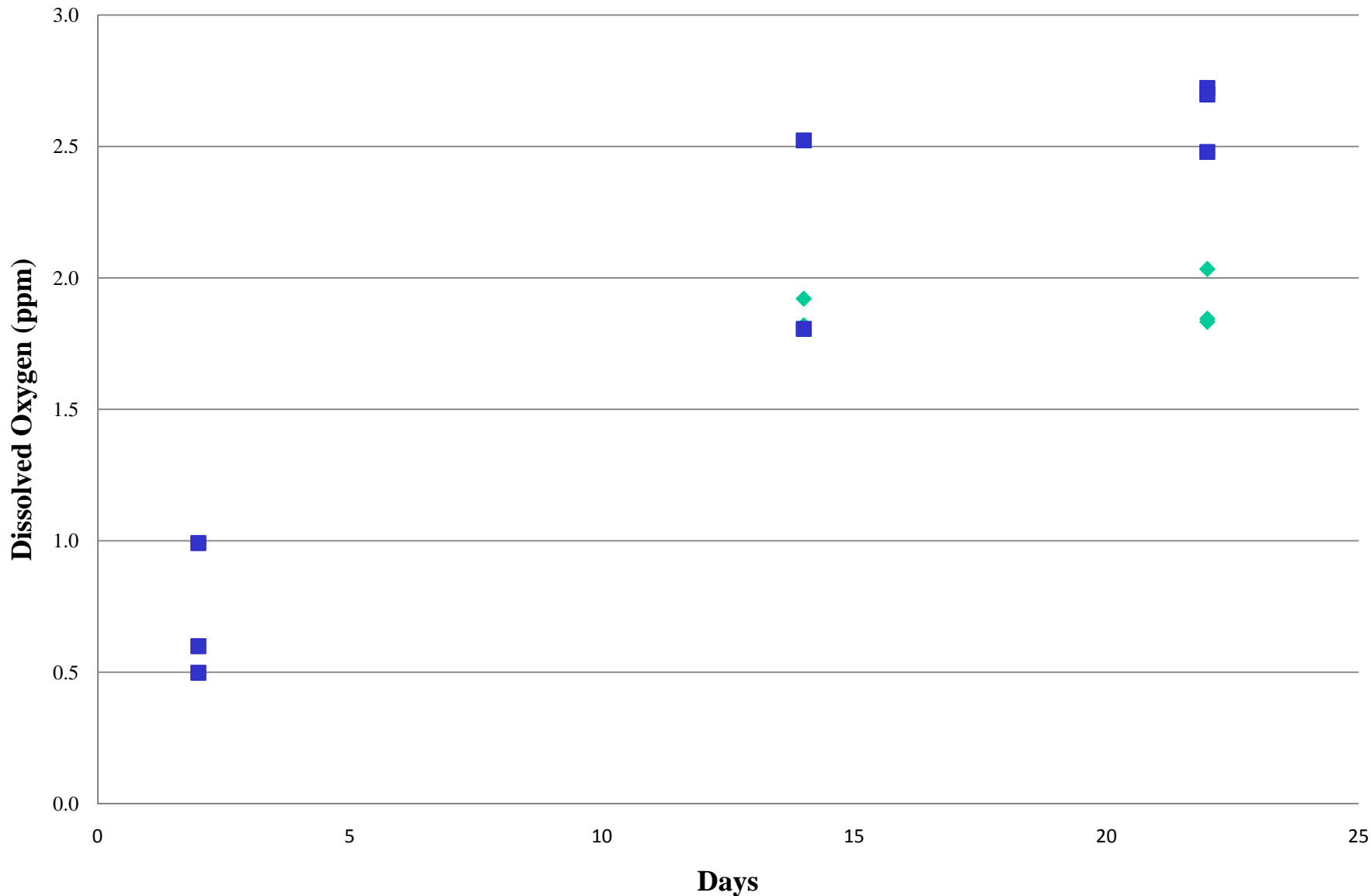
Initial Total package Oxygen as a Function of Headspace Volume - 3 liter bag



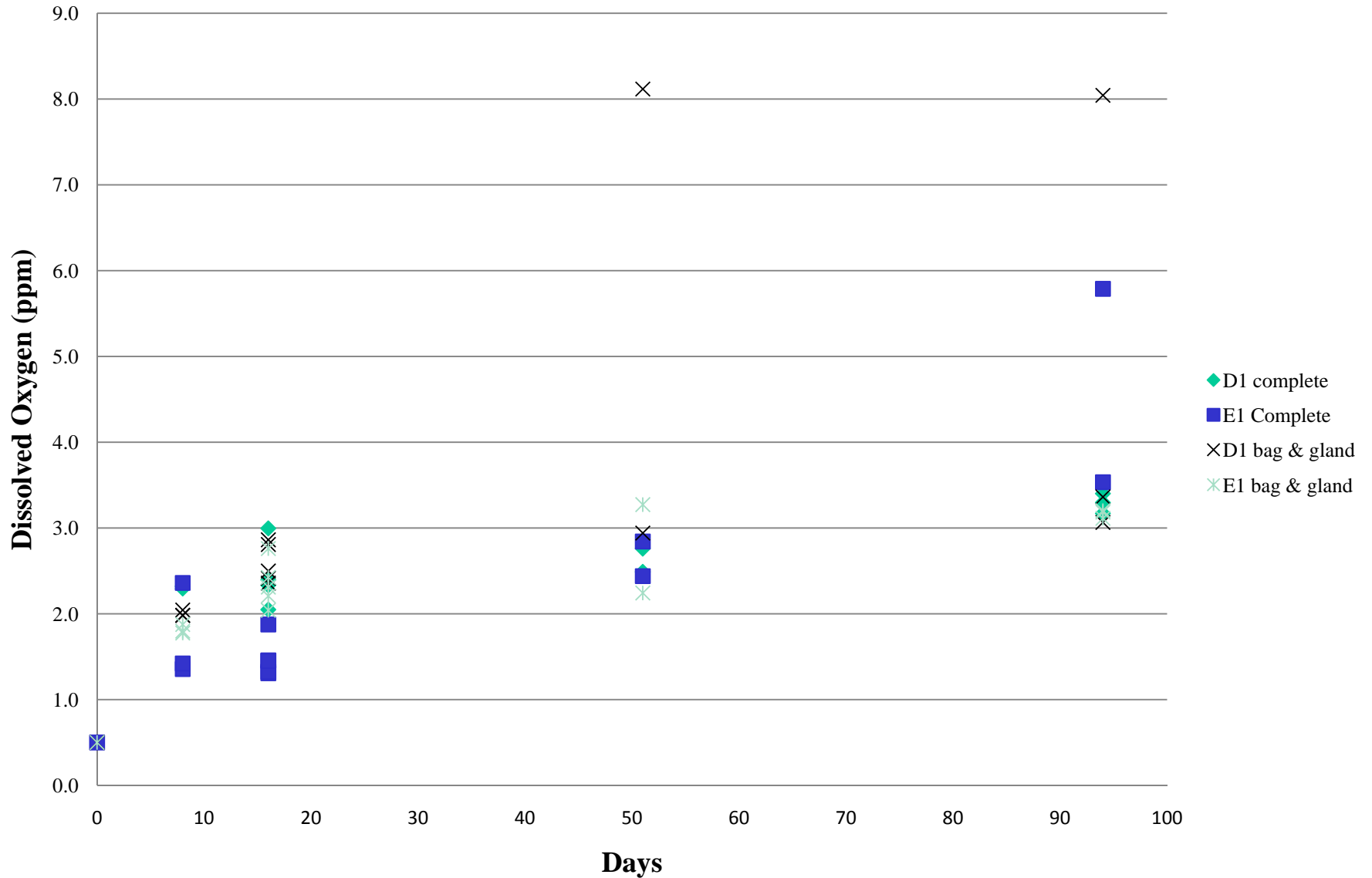
Oxygen Absorbed from the Package

- While conducting oxygen ingress tests we have observed a sharp increase in the oxygen concentration over the first week, then all bags stabilize to a slower ingress rate
- This has also been observed in plastic bottles
- We have seen dissolved oxygen increase between 0.5 to 2 mg/liter in the first week due to absorption
- This does add variability to any test
- Minimizing this would require material and construction changes

Example of Absorption of Oxygen from Package



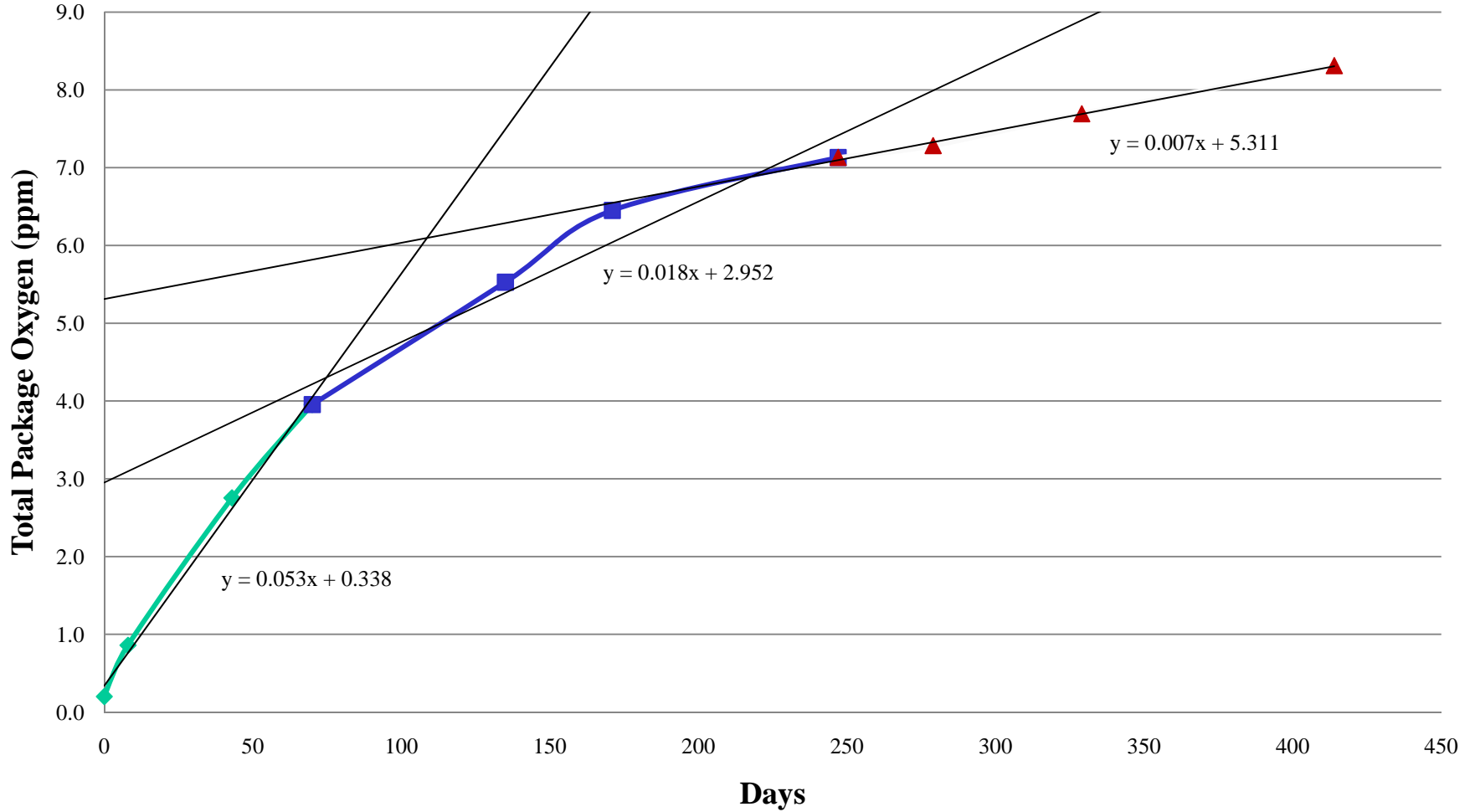
Example of Absorption from Package and Package Failure



Oxygen Ingress

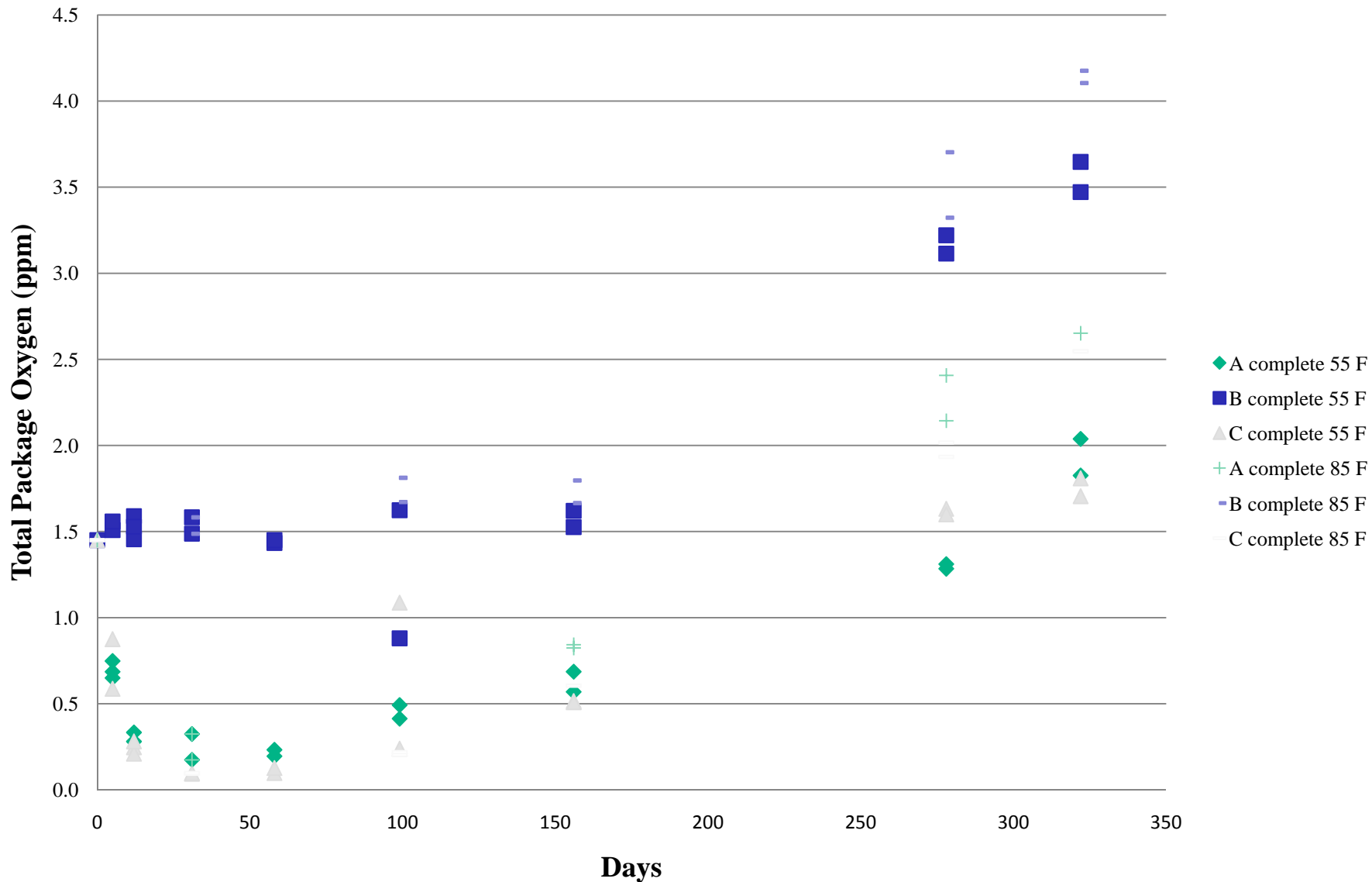
- Steady state
 - Best estimate is determined at lowest oxygen concentration in the package
- Oxygen scavengers
 - May take some time to activate
 - Can have zero or negative ingress rate while functioning
 - Runs out of capacity at some time
 - Can have long term flavor problems
- Bio contamination
 - Looks like a scavenger, very low oxygen levels

Example of Oxygen Ingress Rate as a Function of Oxygen Concentration in Package

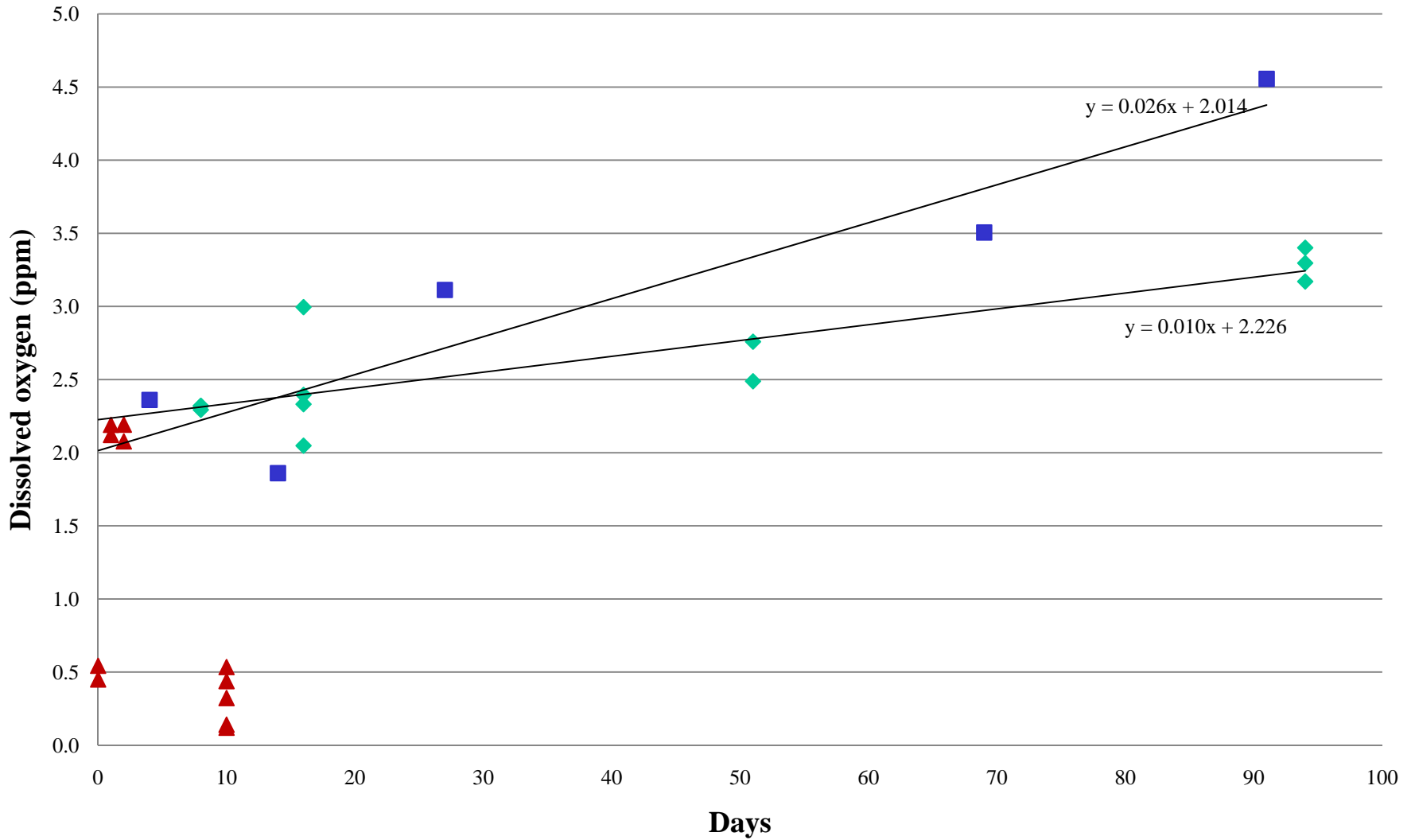


◆ Low initial oxygen ■ Medium initial oxygen ▲ High initial oxygen

Examples of Oxygen Scavenger Containing Bags



Repeated Tests of Different Lots of the Same Bag & Tap



◆ D1 complete ■ D2 complete ▲ D3 complete, contaminated

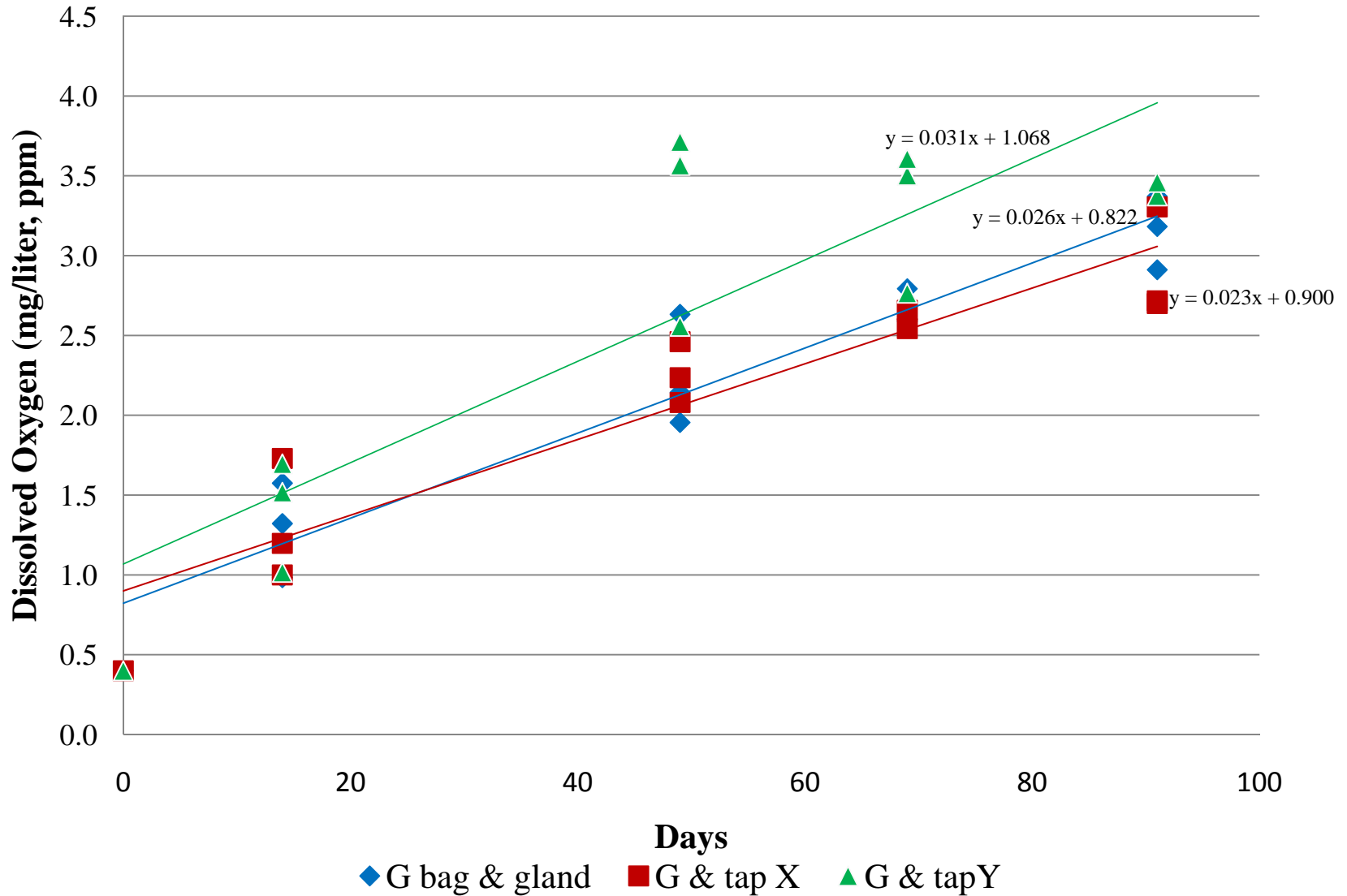
Early Detection of Package Failure

- Ability to detect microgram per liter changes in oxygen level allows detection of the smallest defect in the package
 - Screwcaps that do not leak can have extremely poor barrier properties due to “micro” wrinkles in the gasket
 - Long before bags leak due to stress cracking oxygen levels ingress as air gets in through the minute cracks in the film
- Signs of stress cracking has been observed starting at 3 months

Oxygen Ingress per Component

- Tests are run on the complete package for complete performance
- Aluminum seals are used instead of the tap to measure performance of the bag and gland
 - This can be misleading as there is a measurable ingress through the gland walls that may not occur if the tap seals at the bottom of the gland
- Bags without glands can be tested for bag performance

Comparison of Two Types of Taps on the Same Bag



BIB Oxygen Pick-up

	Low Oxygen (ppm)	High Oxygen (ppm)
Transfer	?	?
Filling	?	?
Headspace	0.5	1.5
Absorption	0.5	2.0
Ingress (6 months)	0	6
6 month total	1+	9.5+

Conclusions & Suggestions

- When using this method it is critical to fill bags at low and consistent oxygen levels
- This method does identify the means by which oxygen is getting into the wine
- Further work may lead to a reliable early detection of package failure by stress cracking
- Stress cracking may be a function of water and ethanol exposure more than physical abuse