## **Hypothesis Testing**

1. **Interpretation of Findings**

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| --- | --- | --- |
| t-Test: Paired Two Sample for Means | | |
|  |  |  |
|  | *Agent1* | *Agent2* |
| Mean | 8.25 | 8.683333333 |
| Variance | 1.059090909 | 1.077878788 |
| Observations | 12 | 12 |
| Pearson Correlation | 0.901055812 |  |
| Hypothesized Mean Difference | 0 |  |
| df | 11 |  |
| t Stat | -3.263938591 |  |
| P(T<=t) one-tail | 0.003772997 |  |
| t Critical one-tail | 1.795884819 |  |
| P(T<=t) two-tail | 0.007545995 |  |
| t Critical two-tail | 2.20098516 |  |

A paired samples t-test was conducted to determine whether there is a significant difference in the population mean impurity levels between Filtration Agent 1 and Filtration Agent 2. The mean impurity level for Agent 1 was 8.25, while that for Agent 2 was 8.68, giving a mean difference of –0.43 (Agent 1 minus Agent 2).

The t-statistic obtained was t(11) = –3.26, with an associated two-tailed p-value of 0.0075. This p-value is below the conventional 5% significance level (α = 0.05). Therefore, the null hypothesis that there is no difference between the mean impurity levels of the two filtration agents can be rejected.

This indicates that there is a statistically significant difference between the two filtration agents in terms of their mean impurity levels. Since the mean impurity for Agent 1 is lower than that for Agent 2, this suggests that Agent 1 is more effective at reducing impurity than Agent 2.

1. **Hypotheses for the two-tailed test**

where .

1. **Assumptions & validity**

The paired t-test assumes:

1. **Paired design** — yes, same batches.
2. **Differences are normally distributed** — the output says “Assuming the data to be suitably distributed,” meaning we assume normality of the differences.
3. **Data are continuous** — impurity measurements are continuous.

To validate normality of differences:

* Could use a Shapiro–Wilk test on the differences.
* Or check histogram/Q–Q plot of differences.

Given n=12, normality is important; but the paired t-test is fairly robust if no severe skew/outliers.

**4. Summary Table**

|  |  |
| --- | --- |
| **Statistic** | **Value** |
| Mean impurity (Agent 1) | 8.25 |
| Mean impurity (Agent 2) | 8.68 |
| t-statistic | –3.26 |
| p-value (two-tailed) | 0.0075 |
| df | 11 |
| Decision | Reject H₀ |
| Conclusion | Significant difference — Agent 1 has lower impurity |

**5. One-tailed Test**

If the hypothesis had been one-tailed, specifically testing whether Agent 1 was more effective (i.e., whether Agent 1’s mean impurity was lower than Agent 2’s), then the one-tailed p-value of 0.0038 would be compared to α = 0.05.

Since 0.0038 < 0.05, the null hypothesis would again be rejected, providing strong evidence that Agent 1 is more effective than Agent 2 in lowering impurity levels.

**6. Conclusion**

Based on both the two-tailed and one-tailed paired t-tests, there is strong statistical evidence that the mean impurity levels differ between the two filtration agents. Specifically, Agent 1 consistently shows lower impurity levels than Agent 2, and this difference is statistically significant at the 5% level. We therefore conclude that Agent 1 is the more effective filtration agent.

## **Appendix**

Data analysis:

