

Design and Analysis of experiments

Factorial Design

- Factorial design is a type of experimental setup that allows researchers to study the effects of two or more factors simultaneously.
- Each factor has multiple levels, and all possible combinations of these levels are included in the experiment.
- This design helps in understanding the interaction effects between factors as well as their individual contributions to the outcome.

2² Design

- A 2² factorial design involves two factors, each with two levels (commonly referred to as *high* and *low*).
- This results in **2² = 4 experimental conditions**.

Example

- **Factor A:** Temperature (High, Low)
- **Factor B:** Pressure (High, Low)

Experimental Conditions

1. High Temperature, High Pressure
2. High Temperature, Low Pressure
3. Low Temperature, High Pressure
4. Low Temperature, Low Pressure

2³ Design

- A 2³ factorial design involves three factors, each with two levels.
- This results in **2³ = 8 experimental conditions**.

Example

- **Factor A:** Temperature (High, Low)
- **Factor B:** Pressure (High, Low)
- **Factor C:** Catalyst (Present, Absent)

Experimental Conditions

1. High Temperature, High Pressure, Catalyst Present
2. High Temperature, High Pressure, Catalyst Absent
3. High Temperature, Low Pressure, Catalyst Present

4. High Temperature, Low Pressure, Catalyst Absent
5. Low Temperature, High Pressure, Catalyst Present
6. Low Temperature, High Pressure, Catalyst Absent
7. Low Temperature, Low Pressure, Catalyst Present
8. Low Temperature, Low Pressure, Catalyst Absent

Advantages of Factorial Design

1. **Efficiency:** Multiple factors are tested simultaneously, reducing the number of experiments needed compared to testing each factor independently.
2. **Interaction Effects:** Allows for the study of how factors interact and influence one another.
3. **Comprehensive Data:** Provides detailed data on both individual and combined factor effects.
4. **Resource Optimization:** Saves time, materials, and effort through efficient design.
5. **Robust Conclusions:** Enables stronger and more generalizable conclusions due to comprehensive exploration of factor combinations.

Response Surface Methodology (RSM)

- Response Surface Methodology (RSM) is a collection of mathematical and statistical techniques useful for developing, improving, and optimizing processes.
- It explores the relationships between several explanatory (input) variables and one or more response (output) variables.
- The primary goal is to use a sequence of designed experiments to determine the optimal response conditions.

Key Steps in RSM

1. Design of Experiments (DoE):

- Systematically plan a series of experiments to explore the influence of input factors.

2. Model Fitting:

- Fit a polynomial model (typically second-order) to the experimental data using regression techniques.

3. Optimization:

- Analyze the model to determine optimal conditions for desired responses.

Detailed Steps in RSM

1. Experimental Design

- Select an appropriate experimental design such as:

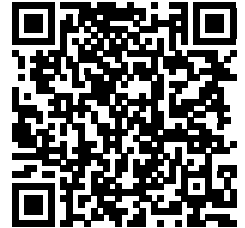


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