

## 机械与动力工程学院博士生资格考试笔试大纲

## Syllabus of Ph.D. Qualification Examination (SJTU-ME)

*笔试主题 Exam Topic	(中文) 高等燃烧学
	(English) Advanced Combustion
*考核形式 Exam Format	闭卷考试, 1 小时 Closed-book exam, 1 hour
*考核目标 Exam Target	<p>学生应理解和掌握与燃烧和反应流相关的物理化学过程, 包括: 燃烧热化学和化学动力学的基础知识, 无碳和含碳燃料燃烧机理以及有害排放生成机理, 层流预混火焰和扩散火焰结构, 液滴蒸发燃烧, 火焰着火和熄火, 燃烧不稳定性等。</p> <p>The candidate of Ph.D must understand the physico-chemical processes related to combustion and reacting flows. The topics to be covered include: chemical thermodynamics, chemical kinetics, carbon free and carbon containing fuels oxidation and pollutant formation mechanisms, laminar premixed/diffusion flames, droplet combustion, ignition/extinction, flame instabilities.</p>
*考核内容 Exam Contents	<ol style="list-style-type: none"> <li>1、掌握燃烧学中当量比、空燃比、燃料类型等相关基础概念; 掌握化学平衡及自发反应等概念; 掌握生成焓、反应热和燃烧热等概念; 掌握绝热火焰温度的概念及其影响因素。</li> <li>2、掌握质量、动量、能量传递现象及理论; 掌握燃烧中的质量守恒方程、动量守恒方程和能量守恒方程。</li> <li>3、掌握总包反应、基元反应、反应级数、反应方程式、反应速率表达式、阿伦尼乌斯公式、活化能、链式反应等化学动力学基本概念; 掌握双分子反应的过渡态理论和单分子反应的林德曼机理。</li> <li>4、掌握 H<sub>2</sub>-O<sub>2</sub> 反应机理和甲烷燃烧反应机理; 理解氮氧化物和碳烟两类燃烧污染物的主要生成机理。</li> <li>5、掌握本生火焰、平面火焰、对冲火焰等层流预混火焰类型; 掌握层流预混火焰的物理结构分析方法及特点; 掌握层流预混火焰的化学结构; 掌握火焰厚度的概念及其影响因素; 掌握火焰传播速度的概念、影响因素及测量方法。</li> <li>6、掌握旋转射流火焰、同轴射流火焰、受限射流火焰、布克舒曼火焰等层流扩散火焰类型; 掌握层流扩散火焰的物理和化学结构; 掌握液体燃料喷雾现象及理论; 掌握液滴蒸发燃烧现象及理论。</li> <li>7、掌握热自燃和点火现象及机理; 掌握 S 曲线概念和预混火焰熄火现象及机理; 掌握着火极限现象及影响因素; 掌握火焰稳定和吹脱的现象、机理及典型稳定方法。</li> </ol> <ol style="list-style-type: none"> <li>1、 Basic concepts of equivalence ratio, air-fuel ratio and fuel type in combustion; Concepts of chemical equilibrium and spontaneous reaction; Concepts of enthalpy of formation, heat of reaction and heat of combustion; Concepts of adiabatic flame temperature and its influencing factors.</li> <li>2、 Mass, momentum, energy transfer phenomenon and theory; mass</li> </ol>

	<p>conservation equation, momentum conservation equation and energy conservation equation in combustion.</p> <p>3、 The basic concepts of chemical kinetics, such as general reaction, basic reaction, reaction series, reaction equation, reaction rate expression, Arrhenius formula, activation energy, chain reaction, etc.; the transition state theory of bimolecular reaction and lineman mechanism of single molecule reaction.</p> <p>4、 The mechanism of H<sub>2</sub>-O<sub>2</sub> reaction and methane combustion reaction; the main formation mechanism of NO<sub>x</sub> and soot.</p> <p>5、 The types of laminar premixed flame, such as Bunsen flame, plane flame, opposed flame, etc.; the physical structure analysis method and characteristics of laminar premixed flame; the chemical structure of laminar premixed flame; the concept of flame thickness and its influencing factors; the concept, influencing factors and measurement methods of flame propagation velocity.</p> <p>6、 The types of laminar diffusion flame such as swirling jet flame, coaxial jet flame, confined jet flame, Booker Schumann flame, physical and chemical structure of laminar diffusion flame, liquid fuel spray phenomenon and theory, droplet evaporation combustion phenomenon and theory.</p> <p>7、 The mechanism of flame stability and blow off, the concept of S-curve, the phenomenon and mechanism of premixed flame flameout, the phenomenon and influencing factors of ignition limit, the phenomenon and mechanism of flame stability and blow off, and the typical methods of flame stability</p>
*参考书目 References	燃烧学导论：概念与应用 An Introduction to Combustion Concepts and Applications
备注 Notes	