1.8 Condensation of real gases

By discussing the condensation of real gases, here as an example CO_2, we will learn much about the standard vocabulary of thermodynamics and various phenomena. The prefix *iso* (Greek: equal) is found in many phrases like isobars, isotropic, etc.. So isotherms represent data measured at constant temperature. In Fig. 1.4 several isotherms for CO_2 in a pV-diagram are shown. Comparing just the shape of the isotherms a critical temperature T_c is found:

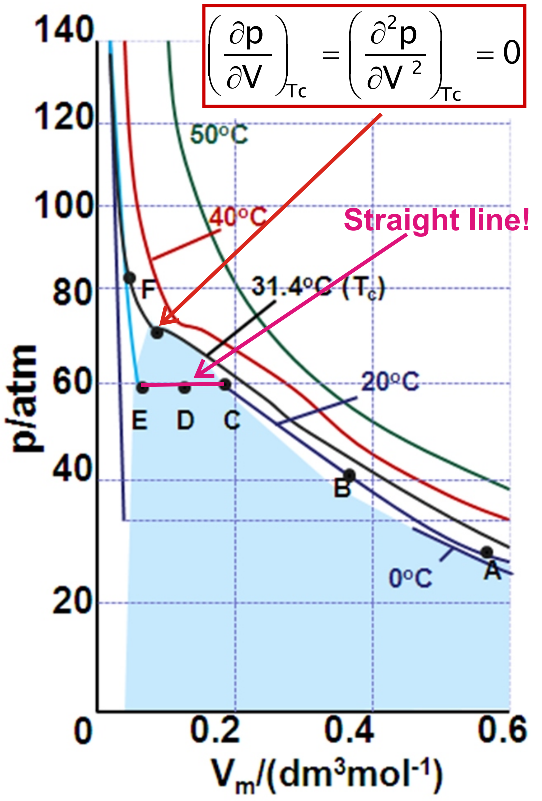

Figure 1.4: pV-diagram of CO_2: Several isotherms

- At the critical point the first and second derivative are zero. To determine the value of the critical point we need a third condition which is the thermal equation of state under consideration. In the next section we will use the Van-der-Waals approach to solve this problem.
- Supercritical isotherms ($T > T_c$) show no buckles / edges. No phase separation exists but one single phase of a supercritical fluid (SCF). Under compression a SFC with high density is formed.
- Subcritical isotherms ($T < T_c$) show buckles / edges. Generally such edges indicate phase separation implying many properties we will discuss later in detail. Here phase separation means that a liquid and a vapor phase exist simultaneously in separated regions of the system. Under compression V_m decreases by condensation, i.e. CO_2(g) (g: gas) is transformed into CO_2(l) (l: liquid).
  In detail the characteristic points in Fig. 1.4 indicate:
  - At C condensation to CO_2(l) starts
  - Along CDE: constant p but increase of CO_2(l) amount
  - Strong slope EF due to compression of pure CO_2(l)
  - Critical point p_c, V_c, T_c: critical constants. The practical meaning of the critical constants will be discussed later.

The properties of gases and fluids discussed here have a large impact for physical/technical processes. E.g. to liquify gases typically high pressure is used. So one could ask the question: Is it possible to produce liquid oxygen by compression at room temperature? The answer is: NO! The temperature must be below the critical temperature, otherwise a supercritical isotherm is present.