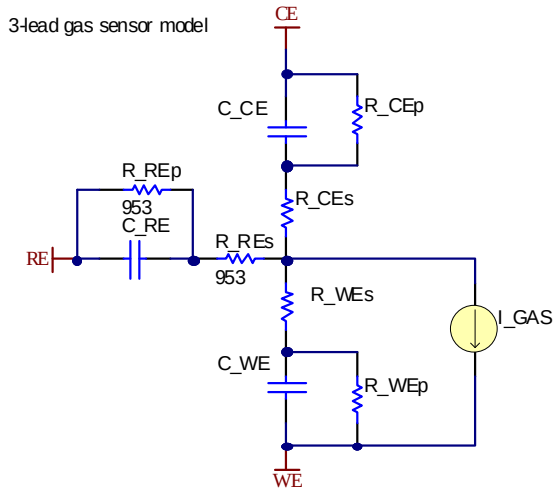
3-lead Amperometric Gas Sensor Model

The amperometric electrochemical gas sensors use three electrodes:
Working electrode reacts with the target gas
Counter electrode generates a current that balances the working electrode current
Reference electrode sets the operating potential of the working electrode for best performance.

All three electrodes are connected internally through the electrolyte, so a common central node is an essential part of the model. The electrolyte can be modeled simply as a resistor (R_CEs, R_REs, R_WEs). Each electrode can be modeled simply as a large capacitor (C_CE, C_RE, C_WE) and small resistive component (R_CEp, R_REsp, R_WEp).
The source current present in the model represents the current generated in the redox reaction that happens at CE and WE electrodes.



Limits of the model

The electrochemical phenomena which take place in the electrochemical cell are complex, non linear and time variant. The proposed electrical model (available in most of the Electrochemical Literature) is a linear and time constant model which simply emphasizes the dominant chemical phenomena (reaction redox, diffusion) which take place at the electrodes and in the electrolyte.

References

AAN-111 “Modelling Amperometric Electrochemical Gas Sensors” from Alphasense.
AAN-105-03 “Designing a Potentiostatic Circuit” from Alphasense.